MAY 1956
No. 214

ASTM Bulletin

59th ANNUAL MEETING
Atlantic City, N. J.
June 17–22

American Society for Testing Materials

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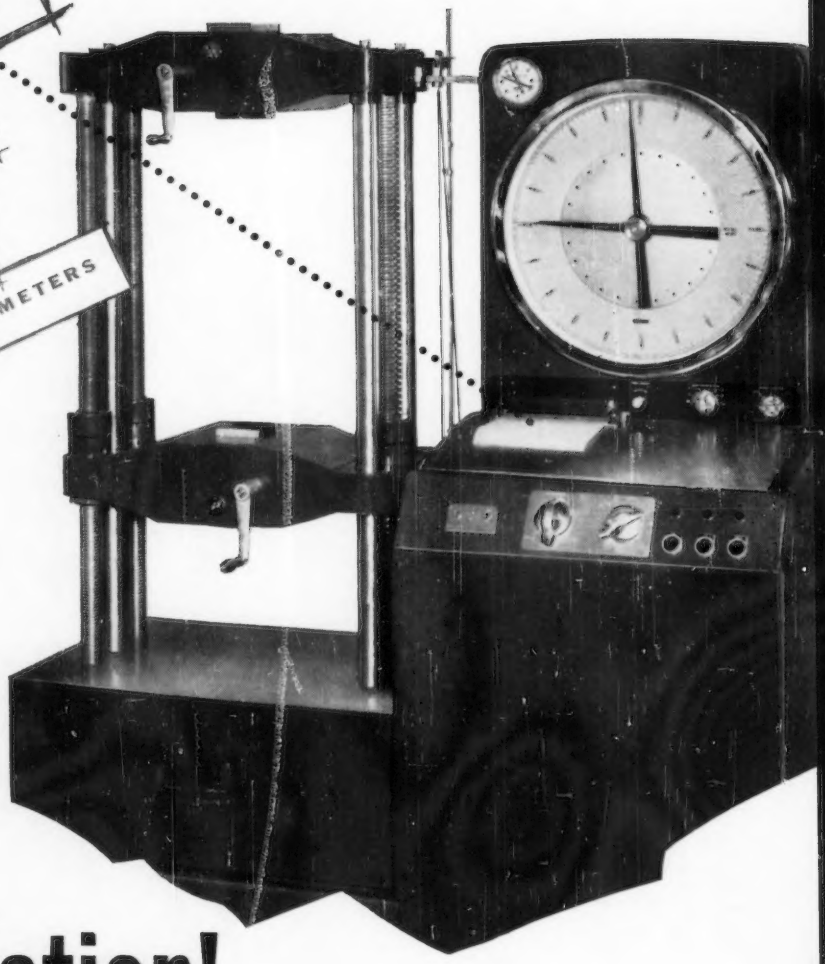

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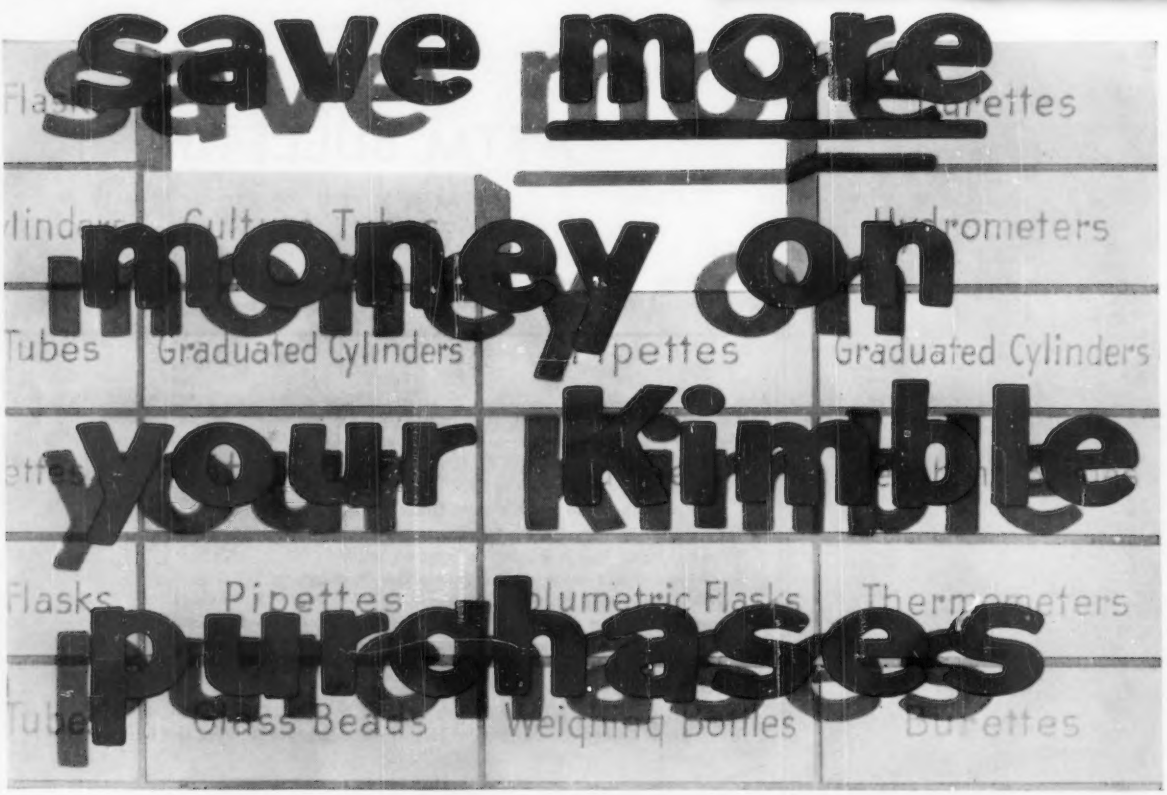

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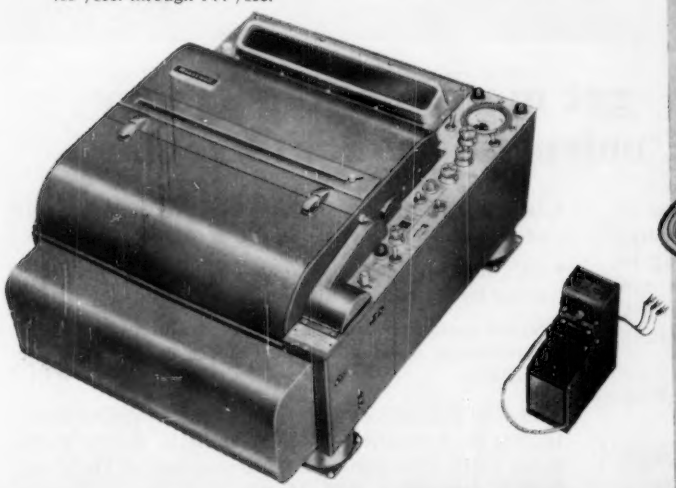

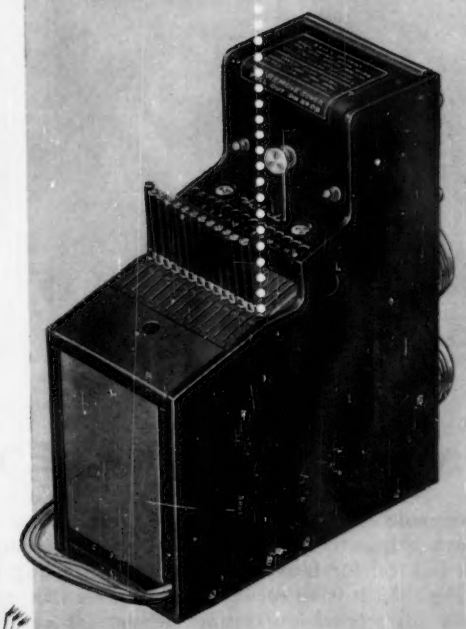

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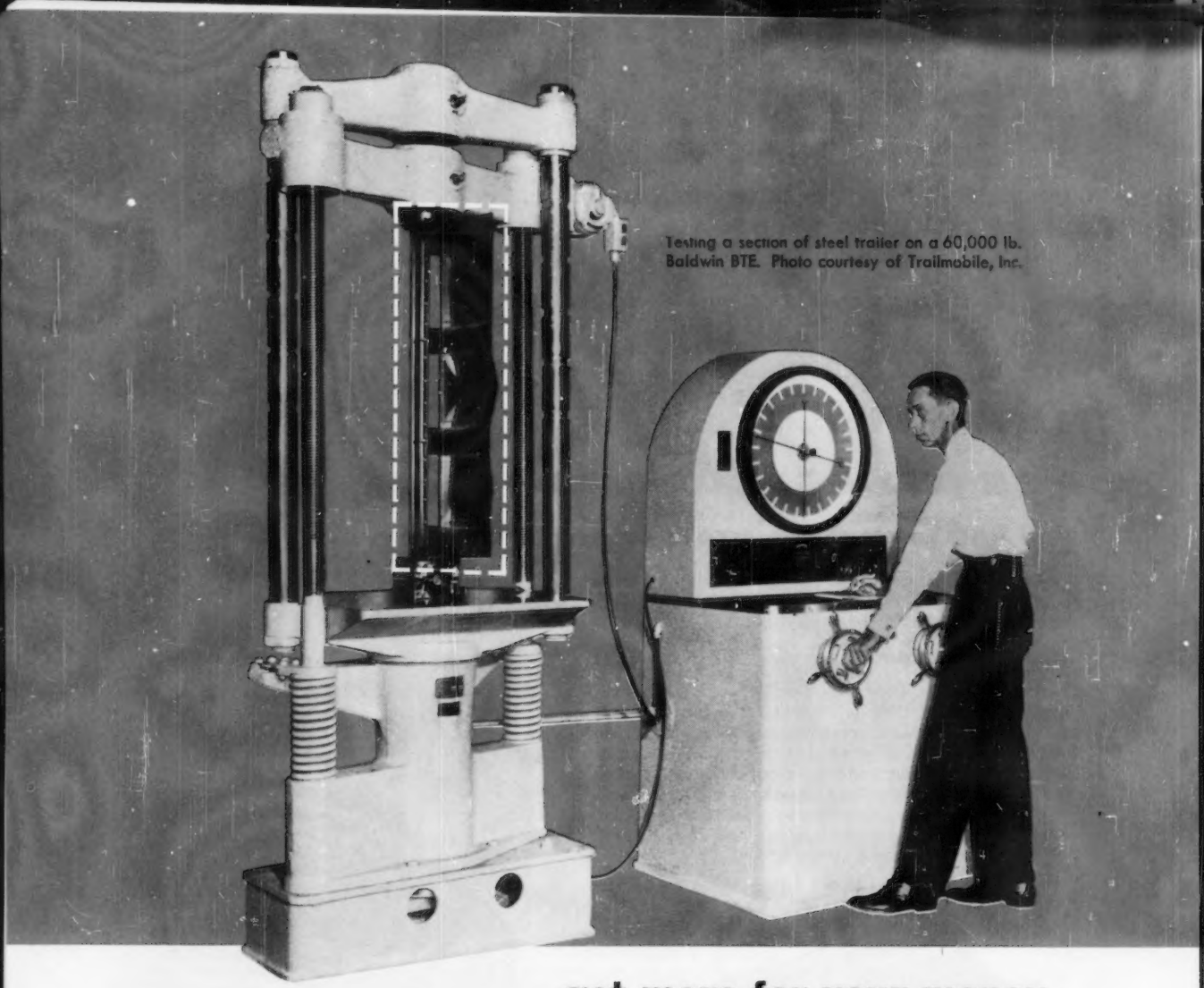

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 214 May 1956

THE ANNUAL MEETING

Climax and Beginning

THE 59th Annual Meeting which will convene the week of June 17 marks, as did all the preceding 58, the end of a year's work and the inauguration of a new period of activities and achievement.

In the formal reports of the technical committees, and the Board of Directors, are summed up a year's work in standardization and research in the materials of engineering. In the technical sessions of the meeting, the Marburg and Gillett Lectures, are begun a new year of ASTM publication—*Proceedings*, symposiums, new standards and revisions of old standards which will appear in compilations and in supplements to the 1955 Book of ASTM Standards.

The Technical Program . . .

In quality and diversity, the technical program is typical of ASTM meetings. As the Provisional Program, published in the April issue of the ASTM BULLETIN shows, there are eight symposiums on the subjects of:

***pH* Measurement**
Tension Testing of Nonmetallic Materials
Solder
In-Place Shear Testing of Foundation Soil by the Vane Method
Specific Gravity of Bituminous Coated Aggregates
Ion Exchange Resins and Chromatography
Steam Testing

In addition to these symposiums are sessions on:

Metals
Concrete
Fatigue
Heat-Resistant and Corrosion-Resistant Steels
Testing (general)
Soils

The Marburg Lecture . . .

Adding new distinction to a notable series of lectures is the Marburg Lecture on Silicones.

In the Marburg Lecture on Wednesday, June 20, Charles E. Reed, general manager of the Silicone Products Dept., of General Electric Co. will discuss the basic chemical structure of silicones with particular reference to their similarities and differences compared with other industrially important polymeric substances, and physical and chemical properties of silicones leading to their industrially important applications. Dr. Reed will take up processes of manufacture, the important types of silicones and their applications, ending with a look into the future of silicones in such industries as electrical, aircraft, protective coating, and textile.

The Gillett Lecture . . .

In the Gillett Lecture, on Tuesday, June 19, D. K. Crampton, director of research and development of Chase Brass and Copper Co., Inc. will explore three aspects of microstructure of copper. The first portion will cover some new work on recrystallization and grain growth of copper alloys, investigating time intervals much shorter than have been used heretofore. Secondly, he will deal with the structural chemistry of copper and its alloys and more particularly the relation of grains and grain boundaries both in pure copper and some copper alloys. Dr. Crampton will then describe new investigations of the fundamentals of corrosion and corrosion resistance of copper and some of the factors affecting the incidence growth of corrosion pits.

The President's Luncheon . . .

The Society's only function dealing exclusively with ASTM affairs and personalities is the President's Luncheon. Featured are the President's Address by retiring President C. H. Fellows; awards of honorary memberships to individuals of widely acknowledged eminence in the fields of work covered by the Society, or who have rendered especially meritorious service to the Society; awards to individuals who have rendered distinguished service to the Society along technical lines; and recognition of 50 and 40-year members. No other technical sessions are scheduled at this time and all committees have been requested to keep the period from 12 noon to 2:30 p.m. free so that all may attend the Luncheon.

The Annual Dinner . . .

The welcome break in the middle of a very busy week will be provided by the Annual Dinner on Wednesday evening. A Dutch-treat cocktail party will precede the dinner and floor show which will feature nationally known entertainers. This event is strictly social—no speeches, no business—entirely set aside for relaxation and opportunity to meet fellow members.

Preprints of Papers and Reports . . .

Each member has received the preprint request blank mailed to all ASTM members on April 13. The First Installment of preprints went into the mail about May 11. A second and third installment of preprints will be mailed on June 1 and June 15, respectively. Registrants at the Annual Meeting will have another opportunity to secure preprints of the various reports and papers. It should be borne in mind, however, that not all reports and papers will be available in time to be preprinted.

Committee Meetings . . .

The detailed list of committee meetings to be held throughout the week will be included in the program given out at the Annual Meeting. As we go to press the following committees plan to meet. Members should consider the committee meeting schedule as tentative, to be superseded by the call of meetings by committee officers; in other words the official notice for committee meetings and subcommittee meetings will be received directly from the secretary of each committee.

A-1 Steel—Sunday, Monday, Tuesday
A-2 Wrought Iron—Tuesday
A-3 Cast Iron—Thursday, Friday
A-5 Corrosion of Iron and Steel—Monday, Tuesday
A-7 Malleable-Iron Castings—Wednesday
A-9 Ferro-Alloys—Wednesday
A-10 Iron-Chromium, Iron-Chromium-Nickel and Related Alloys—Thursday
B-2 Non-Ferrous Metals and Alloys—Monday, Tuesday
B-3 Corrosion of Non-Ferrous Metals and Alloys—Thursday
B-5 Copper and Copper Alloys, Cast and Wrought—Monday
B-6 Die-Cast Metals and Alloys—Tuesday, Wednesday
B-7 Light Metals and Alloys, Cast and Wrought—Monday, Tuesday
C-1 Cement—Wednesday, Thursday
C-3 Chemical-Resistant Mortars—Monday
C-4 Clay Pipe—Monday, Tuesday
C-7 Lime—Thursday, Friday
C-9 Concrete and Concrete Aggregates—Monday, Tuesday
C-11 Gypsum—Thursday, Friday
C-12 Mortars for Unit Masonry—Wednesday
C-15 Manufactured Masonry Units—Monday, Tuesday
C-17 Asbestos-Cement Products—Wednesday
C-21 Ceramic Whitewares and Related Products Cermets Section Monday
D-1 Paint, Varnish, Lacquer, and Related Products—Monday, Tuesday, Wednesday
D-2 Petroleum Products and Lubricants—Monday through Friday
D-4 Road and Paving Materials—Monday, Tuesday, Wednesday
D-5 Coal and Coke—Monday, Tuesday, Wednesday, Thursday
D-6 Paper and Paper Products—Thursday, Friday
D-8 Bituminous Waterproofing and Roofing Materials—Wednesday, Thursday, Friday
D-9 Electrical Insulating Materials—Wednesday, Thursday, Friday
D-11 Rubber and Rubber-Like Materials—Wednesday, Thursday, Friday
D-16 Industrial Aromatic Hydrocarbons and Related Materials—Tuesday, Wednesday
D-17 Naval Stores—Thursday
D-18 Soils for Engineering Purposes—Wednesday, Thursday, Friday
D-19 Industrial Water—Wednesday, Thursday, Friday
D-20 Plastics—Monday, Tuesday, Wednesday
D-24 Carbon Black—(Organization Meeting)—Friday
E-1 Methods of Testing—Tuesday, Wednesday, Thursday
E-2 Emission Spectroscopy—Wednesday, Thursday, Friday
E-3 Chemical Analysis of Metals—Sunday, Monday, Tuesday, Wednesday
E-4 Metallography—Monday, Tuesday, Wednesday
E-5 Fire Tests Sub. IV—Friday
E-7 Nondestructive Testing—Wednesday, Thursday, Friday
E-9 Fatigue—Wednesday
E-11 Quality Control of Materials—Tuesday
E-12 Appearance—Monday
Joint Committee on Effect of Temperature on Properties of Metals—Tuesday, Wednesday, Thursday,
Joint Committee on X-Ray Diffraction Data—Thursday
Joint Committee on Boiler Feedwater Studies—Thursday

Ladies Entertainment . . .

While the following program is not fully crystallized, any changes will be minor and the general nature of this full and interesting program will remain virtually as given here. There will be a registration fee of $4 which will cover all activities with the exception of the President's Luncheon and the annual banquet.

Monday, June 18

9 am	Coffee hour
2:30 pm	"Get acquainted" tea and clairvoyance, either in the form of tea leaves, palm reader, or other type of fortune teller
8 pm	A movie showing the manufacture of Lenox china and a display of various pieces of priceless porcelain.
9 pm	Informal get-together for cards, etc.

Tuesday, June 19

9 am	Coffee hour
12:15 pm	President's luncheon
8 pm	Fashion show

Wednesday, June 20

9 am	Coffee hour
11:am	Boat trip around Atlantic City including bus transportation to and from point of departure
6:30 pm	Social hour, annual banquet, entertainment, *including dancing*

Thursday, June 21

9 am	Coffee hour
12:30 pm	Luncheon at boardwalk hotel followed by illustrated talk on gems or antique silver
8 pm	Informal get-together for cards, etc.

The Apparatus Exhibit . . .

The Society's Twelfth Exhibit of Testing and Scientific Apparatus and Laboratory Supplies will be an outstanding attraction of the Annual Meeting. At this Exhibit, held every-other year, the latest in research and testing apparatus will be displayed by the country's leading manufacturers. Hundreds of items from small, hand-manipulated instruments through electronic control devices and high temperature ovens to universal testing machines will be exhibited.

Exhibit hours are as follows:

Monday	12:00 noon– 9:00 pm
Tuesday	9:00 am– 6:00 pm
Wednesday	9:00 am– 5:30 pm
Thursday	9:00 am– 6:00 pm
Friday	9:00 am– 12:00 pm

The Photographic Exhibit and Traveling Print Show . . .

The Tenth ASTM Photographic Exhibit and Competition will provide an interesting and educational diversion from the series of technical meetings and committee meetings. About 100 to 150 outstanding technical photographs are expected. They will be displayed in an area adjacent to the Apparatus Exhibit.

The Traveling Print Show of the Photographic Society of America will also be on display. It contains 31 photographs selected from the Eleventh Open Exhibit of Technical Photography, held in Boston in 1955.

NEW ASTM PUBLICATIONS

Symposium on Atmospheric Corrosion of Non-Ferrous Metals

MOST OF THE papers presented at this symposium held at the 1956 Annual Meeting mark the close of the program of the atmospheric corrosion of non-ferrous metals exposure tests started some 26 years ago by ASTM Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys. At that time it was, and still is to some extent, the most comprehensive investigation of the atmospheric corrosion properties of non-ferrous metals and alloys ever attempted. One of its objectives was to determine the correlation, if any, between tests of an accelerated laboratory type and atmospheric corrosion. Another was to evaluate the usefulness of changes in tensile properties as a measure of corrosion. Considerable attention was given to the preparation of the metals and alloys included in the test to insure their uniformity and to the collection of complete information on their chemical composition and microstructure. The report of the committee giving all of this information on the test materials is included with the papers of this symposium. Steps were taken to secure data on the changes in properties due to simple aging as distinguished from corrosion.

The test program has been completed with some real accomplishment. Useful information has been collected and published that in all probability would not have developed otherwise. Much has been learned about planning similar tests, on how specimens should be exposed and tested, and the vital necessity of securing a greater degree of permanency for test site locations. The committee's difficulties with the latter were in no small way responsible for the formation of the Society's Advisory Committee on Corrosion and its acquisition of permanent test locations and adequate exposure test facilities.

In addition to the papers primarily based upon the tests of Subcommittee VI on Atmospheric Corrosion, two papers are added from collaborators who ran roughly parallel tests on similar materials, and two additional papers based upon the galvanic couple tests of Subcommittee VIII on Weather. These papers have been included for the purpose of broadening the base of the symposium and providing additional information on the atmospheric corrosion of non-ferrous metals.

Titles and authors of the papers are as follows:

Introduction—*W. H. Finkeldey, Singmaster & Breyer*

The Resistance of Aluminum-Base Alloys to 20-year Atmospheric Exposure—*C. J. Walton and William King, Aluminum Company of America.*

Effect of Marine and Urban Atmospheres on Aluminum Alloys—*F. M. Reinhart and G. A. Ellinger, National Bureau of Standards.*

Effect of Natural Atmospheres on Copper Alloys—20-year Test—*A. W. Tracy, The American Brass Co.*

Atmospheric Corrosion of Copper-Results of 20-year Test—*D. H. Thompson, A. W. Tracy, and J. R. Freeman, Jr., The American Brass Co.*

Atmospheric Galvanic Corrosion of Dissimilar Metal Couples—*H. O. Teeple, The International Nickel Co., Inc.*

Galvanic Couple Corrosion Studies by Means of the Threaded Spool and Wire Test—*K. G. Compton and A. Mendizza, Bell Telephone Laboratories, Inc.*

The Atmospheric Corrosion of Rolled Zinc—*E. A. Anderson, The New Jersey Zinc Co. (of Pa.)*

The Use of Lead and Tin Outdoors—*G. O. Hiers and E. J. Minarcik, National Lead Co.*

Atmospheric Corrosion Behavior of Some Nickel Alloys—*H. R. Copson, The International Nickel Co., Inc.*

This 120-page publication, *STP 175* can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $2.75; to members, $2.

Significance of ASTM Test for Petroleum Products

THIS third edition was prepared for the reader who wishes to acquire a general idea of the significance of the various ASTM Methods of Test that relate to petroleum products. A brief outline of these methods of test and their relation to the performance characteristics of specific products is also discussed, so that the reader may have some idea of the applications of the various methods. This book covers only the methods of test that apply to petroleum products, including lubricants and crude petroleum. The language has been kept relatively free of technical terms for those who may not be acquainted with such terms.

In a treatise, covering so many test methods that are applicable to so many products, it is impossible to discuss or even mention all of the applications of these methods and their significance in predicting performance characteristics. In many cases there are valid differences of opinion as to the interpretation of laboratory test data in terms of performance. Newly designed equipment, new methods of operation and maintenance may require new petroleum products that require new laboratory methods of test. For these reasons, discussion must of necessity be brief and of a general nature.

The outlines of the methods of test in this book are not adequate for conducting tests. Full details and the necessary safety precautions required for each method are given in the annual official publication "ASTM Standards on Petroleum Products and Lubricants." Each standard has a permanent designation number, with a suffix to indicate the year of publication or latest revision. These dating suffixes have been omitted in this book because significance of the methods does not change when minor test details are revised from year to year.

In this book, the methods of test and their significance are discussed in eleven chapters as determined by general properties. The arrangement is: (1) Sampling Petroleum Products, (2) Measurement and Calculation of Volume, (3) Volatility, (4) Combustion, (5) Oxidation Characteristics, (6) Flow Characteristics and Solidification, (7) Corrosion, (8) Other Physical Characteristics and Tests, (9) Chemical Analyses and Tests, (10) Analysis for Hydrocarbon Types, and (11) Butadiene Analysis.

When necessary for good readability and context, the methods of test within a section are further subdivided and discussed either singly or by groups.

Copies of this 134-page publication, *STP 7-B*, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $2.50; to members, $1.85. Add 75 cents to these prices for cloth covers.

Symposium on Impact Testing

THIS SYMPOSIUM brings together several papers on the theory of impact testing and reporting of experimental results of years of research in this important field. Sponsored at the 1955 Annual Meeting of the Society by Committee E-1 on Methods of Testing, the symposium was intended to facilitate the understanding of impact testing in the light of the most recent advances as well as to point out some of the gaps in present knowledge.

Papers on shock tests included in this symposium were to encompass impact in parts, components, and complete structures, and not confine the symposium to notched bar testing. This broadened scope was undertaken with very beneficial enhancement of the practical application of the impact test and of testing at high straining rates. The end result is an excellent balance between theory and experimental results. It will serve as a reference in the laboratory for its descriptions of technical details of impact experimentation and for a general understanding of the technical background. Duplication of material by different authors is limited to a few isolated instances.

Appropriate references to the literature are included, both for background reading and for details concerning specialized subjects. There are numerous graphs, diagrams, tables, and photographs, all contributing toward the understanding of the details described in each paper.

Included in the symposium are the following papers:

Notched-Bar Testing—Theory and Practice—*S. L. Hoyt, metallurgical consultant*

Transition Behavior in V-Notch Charpy Slow-Bend Tests—*C. E. Hartbower, Watertown Arsenal*

Effects of Manganese and Aluminum Contents on Transition Temperature of Normalized Nickel Steel—*T. N. Armstrong and O. O. Miller, International Nickel Co.*

Low Temperature Transition of Normalized Carbon-Manganese Steels—*T. N. Armstrong, International Nickel Co., and W. L. Warner, Watertown Arsenal*

Effect of Specimen Width on the Notched Bar Impact Properties of Quenched-and-Tempered and Normalized Steels—*R. S. Zeno, General Electric Co.*

Reproducibility of Charpy Impact Test—*D. E. Driscoll, Watertown Arsenal*

Automatic Impact Testing from Room Temperature to −236 C—*S. DeSisto, Watertown Arsenal*

The Influence of Pendulum Flexibilities on Impact Energy Measurements—*J. I. Bluhm, Watertown Arsenal*

The Impact Tube: A New Experimental Technique for Applying Impulse Loads—*G. Gerard, New York University, College of Engineering*

Longitudinal Impact Tests of Long Bars with a Slingshot Machine—*W. Ramberg and L. K. Irwin, National Bureau of Standards*

Stress-Strain Relationships in Yarns Subjected to Rapid Impact Loading—*H. F. Schiefer, J. C. Smith, F. L. McCrackin, and W. K. Stone, National Bureau of Standards*

Shock Tester for Shipping Containers—*W. H. Cross and M. McWhirter, Sandia Corp.*

Shock Testing With the Rocket-Powered Pendulum—*R. W. Hager, Sandia Corp.*

Properties of Concrete at High Rates of Loading—*D. Watstein, National Bureau of Standards*

Copies of this 180-page publication, *STP 176*, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $3.50; to members, $2.65.

The Mechanical Properties of Wrought Phosphor Bronze Alloys

THIS paper by G. R. Gohn, Jr., P. Guerard, and H. S. Freynik was presented before the 1955 Fall Meeting of ASTM Committee B-5 on Copper and Copper Alloys, in Philadelphia, Pa. The section covering fatigue testing was presented at the Annual Meeting of the Society in June 1955. Although the investigation was not sponsored by ASTM, Committee B-5 has a direct interest in the data because of its jurisdiction over the Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar (B 103). On several occasions during the past 12 years, changes have been suggested in some of the mechanical properties of this specification, but each proposal has been questioned because of the lack of substantiating data.

The paper covers a most systematic study of the effect on mechanical properties of phosphor bronze strip, resulting from: (1) variations in tin and phosphorus contents, (2) cold working, and (3) variations in grain size. The data presented provide Committee B-5 with a basis for the review of the requirements of Specification B 103 to determine the possibility of establishing more realistic specification limits on the particular tin alloys. Because of the outstanding nature of this investigation and the inestimable value of the data, Committee B-5 sponsored the publication of this paper as a special technical publication which would be readily available for use of future ASTM investigators.

Copies of this 120-page publication, *ASTM STP 183*, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $3; to ASTM Members, $2.25.

Symposium on High-Purity-Water Corrosion

PARTICULARLY timely as the era of commercial development of atomic power opens up is this symposium on High-Purity-Water Corrosion. High-purity water is a necessity in nuclear reactor systems and much of the material presented here deals specifically with such systems as well as with the operation of conventional high-temperature, high-pressure generators.

The symposium, held at the 1955 Annual Meeting, was sponsored by ASTM Committee D-19 on Industrial Water. Together with discussion, it includes the following papers:

The Preparation and Maintenance of High-Purity Water—*F. N. Alquist*

The Use of Water in Atomic Reactors—*H. W. Huntley and S. Untermyer*

Influence of Water Composition on Corrosion in High-Temperature, High-Purity Water—*D. M. Wroughton, J. M. Seamon, and P. E. Brown*

Effect of Material Composition in High-Temperature Water Corrosion—*A. H. Roebuck*

Special Corrosion Study of Carbon and Low-Alloy Steels—*R. U. Blaser and J. J. Owens*

Copies of this 60-page publication, *ASTM STP 179*, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $1.75; to members, $1.35.

Index to Standards

THE Society's Index to the 1955 Book of ASTM Standards has been completed and is being mailed to all members and committee members of the Society. Those who have not already received their copies may expect to receive them shortly.

Containing 10 per cent more listings than the 1954 Index, the new edition covers 1274 standards and 879 tentatives for a total of 2153.

Subjects have been indexed under appropriate key words, and items under each subject are arranged alphabetically according to the significant word in the title. There is also a list of standards in continuous numeric sequence of ASTM serial designations. This list gives the complete title and the page number and part of the Book in which each standard may be found. When the ASTM designation of a particular standard is known, this list is especially useful.

Ultraviolet Spectral Absorption Index Cards

THERE is now available an expanded deck of ASTM-Wyandotte cards indexing ultraviolet spectra. The complete deck consists of 7066 cards from the following sources:

Source	*Number of Cards*
American Petroleum Institute	571
Abstracted from literature	6495
Total	7066

The price of the complete deck is $90 and includes a copy of the book of "Codes and Instructions for Wyandotte-ASTM Punched Cards Indexing Spectral Absorption Data."

Also available are two supplements to the original 1284-card deck which will expand it to full coverage. A 3916-card supplement is available for $50 and a further 1867-card supplement is available for $24.

The Wyandotte-ASTM index cards can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

Empirical Formula–Name Index Cards for Infrared and Spectral Data

ORGANIC chemists and analysts working in the infrared field have been brought closer together by a recent development in indexing infrared and similar spectral data. ASTM now sells a set of index cards that allows one to determine whether a particular compound has had its infrared absorption characterized and published in a recognized journal or collection of spectra.

The index is unique in that it does not require the use of IBM or similar card-sorting machines. The deck of index cards numbering almost 14,000, was prepared using IBM accounting equipment to code the data, sort the cards into order by empirical formula, and print an abbreviated name on the card.

Once installed in a laboratory, anyone can manually search the deck for spectral references on compounds of interest.

For example, an organic chemist might want to see the infrared curve of acetylsalicylic acid. He ignores the name and looks for cards bearing the notation $C_9H_8O_4$. He then looks over the one or more cards in the file carrying this notation until the name of the one sought is located. This card bears a number which tells where to locate the spectrum of interest. As will sometimes happen, he may not have copies of the spectra available but numerical lists of available spectra tell whether to go to a particular American Petroleum Inst. reference, to a Sadtler spectrum, or to a journal reference such as the *Journal of the American Chemical Society, Analytical Chemistry*, or *Journal of the Optical Society of America*.

This index will be of value to both well established spectroscopic laboratories and to individual scientists who want to study specific problems where they depend upon having service laboratories run spectra for them and then compare them with related spectra which they trace down through the medium of this new index.

The present deck covers the spectra indexed in the current 10,969-card Wyandotte-ASTM punched-card index of infrared spectra. There are 13,899 cards in the formula-name deck covering spectra from the following sources:

Source	*Number of Cards*
Samuel P. Sadtler and Son, Inc.	7215
American Petroleum Institute	976
National Research Council	438
Abstracted from literature	2340
Trailers (used where length of name or formula requires a second card)	2930
Total	13899

The price of a deck is $195 and includes a copy of the book of "Codes and Instructions for ASTM Empirical Formula-Name Index Cards Indexing Chemical Compounds."

The index can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

Rubber Glossary

THIS publication, painstakingly compiled by a subcommittee of ASTM Committee D-11 on Rubber and Rubber-like Materials, contains about 1500 terms used in the rubber field.

About one-third of these terms are from the glossary published in the *Vanderbilt News* in 1932 which has been reviewed and revised. A number of terms have been taken from the "Glossary of Terms for Visible Defects Occurring in Rubber Manufacture" (NAVSHIPS 250-344-1). Various other reference books and journals have been used as sources for terms which have not appeared in these glossaries.

Published as *STP No. 184*, this 128-page glossary can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $3; to members, $2.25.

Standards on Metallic Electric Conductors

THIS compilation makes available in one volume acceptable testing procedures and sampling methods and specifications covering quality and other essential features of bare metallic conductors developed under the aegis of ASTM Committee B-1 on Wires for Electrical Conductors.

The 53 standards in this compilation cover (*a*) copper, copper-alloy and copper-covered steel wire, stranded conductors, rod, bar, shapes, pipe and tube, (*b*) aluminum wire, stranded conductors, rod, and bar, (*c*) galvanized iron and steel guy, messenger, span, overhead ground and line wire, (*d*) nonferrous metals, and (*e*) general methods of testing.

These standards (300 pages in heavy paper covers) may be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $3.50; to members, $2.65.

Symposium on Evaluation of Insulation Oils—European Developments

THIS symposium, the sixth in a series on insulating oils sponsored by Subcommittee IV on Liquid Insulation of ASTM Committee D-9 on Electrical Insulating Materials, was held at the meeting of the committee in late 1954. It reports developments in the testing of transforming oils and consists of the following three papers on research in France, Sweden, and England:

Catalysts for Accelerated Aging Testing of Transformer Oil—*Halvard Liander and Gosia Ericson, ASEA, Vasteras, Sweden*

The Performance Characteristics of Used Insulating Oil—*T. Saiomon, Institut Français du Petrole, Paris, France*

The Evaluation of Inhibited Transformer Oils—*R. Irving and D. W. Bravey, The Shell Petroleum Co., Ltd. London, England*

The first two symposiums on this subject were published in the ASTM BULLETINS No. 146, May, 1947, and No. 149, December, 1947. The third, fourth, and fifth symposiums appeared as *ASTM Special Technical Publications Nos. 95, 135*, and *152*.

This publication, *STP 172*, totaling 78 pages, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $1.75; to members $1.35.

Second Pacific Area National Meeting Los Angeles, September 17-21

THE SECOND Pacific Area National Meeting is becoming a problem—a problem the Society can be proud of. For more than a year members of the General Committee on Arrangements for the meeting, composed predominantly of Los Angeles members but including a large number from Northern California and other western states, have been devoting themselves unselfishly to a myriad of tasks in preparation for an outstanding meeting. The problem that faces the Committee and the Staff is how to include in one week all of the technical program, functions, and activities proposed. As a result, there is definite assurance that it will be one of the most important meetings the Society has ever had. The technical program is outstanding. Details have gone out in a provisional program mailed to all Society members and committee members this month, with further information to come in the July BULLETIN.

Pacific Coast Meeting Headquarters—Los Angeles' Hotel Statler

The Technical Program . . .

THE FOLLOWING is a list of the symposiums and special sessions planned for presentation at the West Coast meeting. The highlights of some of the subjects to be covered in these sessions or symposiums are also given.

Symposium on Railroad Materials

Session I on Diesel Fuels and Lubricants covering operation, lubricating problems, performance and utilization of heavy fuels.

Session II on Diesel Fuels and Lubricants—Cleaning Materials

Symposium on Titanium

(Sponsored by Committee B-2 on Non-Ferrous Metals and Alloys and Administrative Committee on Research)

Stress in thermal stability—stress-rupture properties—elevated temperature—statics of analysis—measurement of elastic modulus—ignition and cracking—properties of sheet, bar, extrusions and forgings and pure titanium sheet—statistical control—sampling, testing, and analysis.

Non-Ferrous Session

Pit depth measurements

Ferrous Session

Shotpeening effects and specifications—strength and fatigue of steel in torsion—evolution of hydrogen from arc welds—testing of stainless steel columns

Symposium on Properties, Test and Performance of Electrodeposited Metallic Coatings

(Presented at the Spring Meeting of the Society in Buffalo, N. Y., February 29, 1956)

(Sponsored by B-8 on Electrodeposited Metallic Coatings)

Corrosion behavior of copper-nickel chromium, nickel-chromium, and zinc and cadmium coatings—surface luster—metal cleaning—evaluation of coatings—atmospheric exposure—salt spray test—radioactive isotope method for determining sulfate concentration—phosphate coating.

Session on Cement

(Sponsored by Committee C-1 on Cement)

Hydrophobic cement—storage effect on air-entraining cements—chemical reactivity—determination of magnesia by flame photometry.

Session on Concrete

(Sponsored by Committee C-9 on Concrete and Concrete Aggregates)

Pozzolans—prestressed members—statistical method for determining composition—aggregate quality effect on resistance to abrasion—partial replacement of Portland cement in concrete.

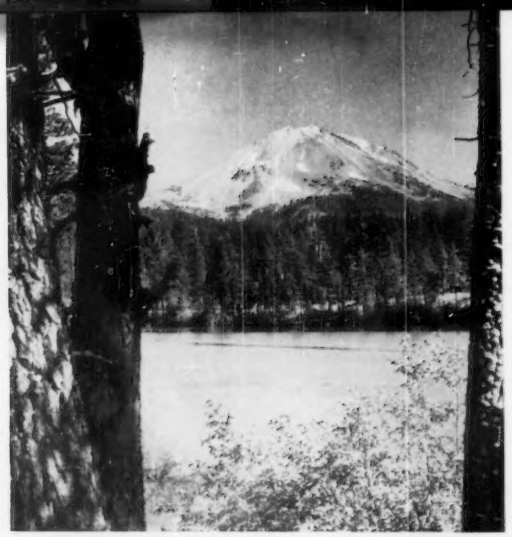
Session on Masonry

Reinforced-concrete beams—testing clay pipe—testing brick masonry to resist blast forces—influence of process and cost on sampling in ceramics—testing plain, grouted and reinforced grouted brick masonry—effects of thickness and age of capping compounds—testing brick, mortar, and grout (color film)—pre-fabricating ceramic veneer.

Symposium on Structural Sandwich Constructions

(Sponsored by Committee C-19 on Structural Sandwich Constructions)

Paper honeycomb panels—naval construction—high temperature testing of adhesives for aircraft—architectural sandwiches—ultrasonic technique for structural adhesive bond evaluation—aluminum honeycomb shear strength—peel tests—recent developments and trends—design of helicopters—honeycomb applications—metal to resin adhesion.



Southern Pacific

Mt. Lassen in California—the only live volcano in the U. S.

Symposium on Industrial Water

(Sponsored by Committee D-19 on Industrial Water)

Industrial waste problems—pollution control—developments in water technology for nuclear reactors—sea water purification—use of flocculants in treatment of water.

Session on Plastics

(Sponsored by Committee D-20 on Plastics)

Correlations between electrical and mechanical measurement—architectural applications for clear polyesters.

Symposium on Full-Scale Tests on House Structures

(Sponsored by Committee E-6 on Methods of Testing Building Constructions)

ASTM Activity in Nondestructive Testing

(Sponsored by Committee E-7 on Nondestructive Testing)

Radiographic inspection—magnetic particle and penetrant testing—reference radiographs—activities and future projects of ultrasonic subcommittee of E-7.

Symposium on Nondestructive Testing

(Sponsored by Committee E-7 on Nondestructive Testing)

Electronic X-ray image systems—ultrasonic inspection—ultrasonic attenuation and velocity measurements—testing heavy metals—evaluation of isotopes in industrial radiography—eddy current in industry—testing on Southern Pacific Railroad—detection of cracks in small cylindrical specimens.

Fatigue Session

(Sponsored by Committee E-9 on Fatigue)

Effect of temperature and frequency on high purity aluminum—effect of forming on mechanical properties—rehabilitation of fatigue-weary structures—fatigue crack initiation and propagation in magnesium—properties of high strength steels.

Symposium on Radioactive Isotopes

(Sponsored by Committee E-10 on Radioactive Isotopes)

Soil density and soil moisture determination—electroplating and metal preservation utilizing radioisotopes—ASTM specifications when applied to metals subject to neutron irradiation in service—specifications for irradiated organic materials—thickness and concentration gaging—radioactive tracers in study of soil removal and detergency—application of beta ray thickness gage to traffic paint wear studies—evaluation of rubber deterioration—application of radioactive tracers to industry—determination of naphthalene—autoradiography—radioactive luminous markers—activation analysis—radiation dosimetry.

Symposium on Radiation Effects of Materials

(Sponsored by Subcommittee on Radiation Effects of Atomic Industrial Forum and ASTM Committee E-10 on Radioactive Isotopes)

The three main headings for this symposium are:

Theory

Radiation Facilities and Mechanics of Testing

Experimental—Fuel and Graphite Materials and Structural Materials Including Organics

Miscellaneous Session

Specifications in buying rubber parts—testing guided missile industry—solvent degreasing.

Structural Chemistry and Metallurgy of Copper

(This modified version of the 1956 Gillett Lecture will be a feature of the meeting, probably at one of the regular sessions.)

Symposium on Paint

Silicones—surface treatments—coatings for railroad industry—vinyl coatings—municipal use—marine environments—phosphatizing systems—glare-reducing window coatings

Symposium on Vapor Phase Oxidation of Gasoline

(Sponsored by Technical Committee on Gasoline of Committee D-2 on Petroleum Products and Lubricants)

Intake system deposits—induction system gum—intake valve deposit—induction system reactions—vapor phase oxidation.

Symposium on Turbine Oils

(Sponsored by Technical Committee C on Turbine Oils of Committee D-2 on Petroleum Products and Lubricants)

Anti-wear requirements—evaluation and performance—antirust additives—effect of water leaching on performance—expected life of used oils—rusting—fire resistant fluids.

Symposium on Lubricating Oil

(Sponsored by Research Division III on Elemental Analysis and Technical Committee B on Lubricating Oils of Committee D-2 on Petroleum Products and Lubricants)

Part I on Spectrographic Analysis of Lubricating Oils covering spectrographic control and analysis—X-ray spectrography—sampling—determination of metals in used oils.

Part II General Papers on Diesel Engine Lubricants covering unsolved problems in analysis—chromatography—filtration.

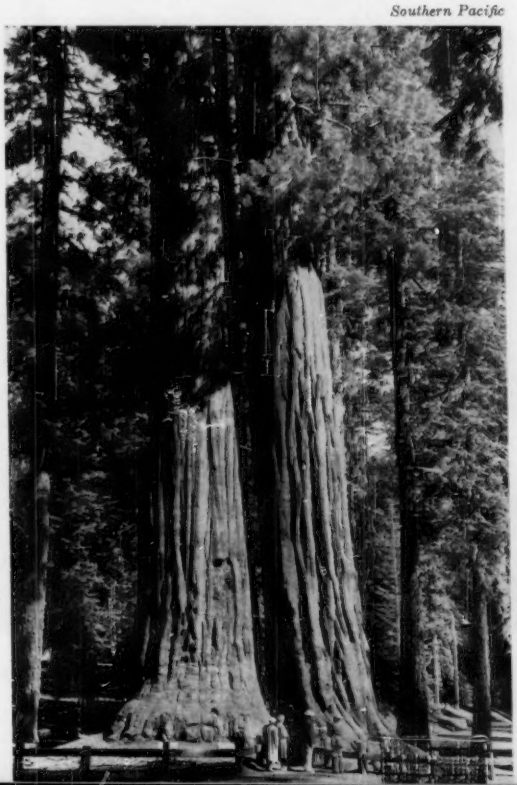
Session on Road and Paving Materials

(Sponsored by Committee D-4 on Road and Paving Materials)

Effect of shape, size and surface roughness of aggregate on strength of granular materials—infrared weathering machine—corre-

California's sequoias—oldest living things.

Southern Pacific



lation between laboratories on ASTM tests—correlation of thin film oven tests with airfield performance—microviscometer for measuring consistency—oven tests.

Symposium on Wood Poles

(Sponsored by Committee D-7 on Wood)

Transmission and communication lines—production in relation to the forest resource—ASTM wood pole research program—specifications.

Symposium on Wood for Marine Use and Its Protection from Marine Organism

(Sponsored by Committee on Wood)

Wood borers—exposure tests—heavy metal compounds as borer inhibitors—agents for protecting wood—resistance to borers in Hawaiian waters.

Symposium on Building Design for Seismic and Shock Loading

(Sponsored by Committees D-7 on Wood and E-6 on Methods of Testing Building Constructions)

Design problems—Oregon Forest Products laboratory tests—U. S. Forest Products laboratory tests—school building design.

Symposium on Development in Glued-Laminated and Other Wood Constructions

(Sponsored by Committees D-7 on Wood and E-6 on Methods of Testing Building Constructions)

Factors affecting strength and design—range in strength qualities—plywood design.

Session on Soils

(Sponsored by Committee D-18 on Soils for Engineering Purposes)

Earth pressure—lateral pressure by compacting soil—evaluating friction and cohesion by consolidated direct shear test—field tests on laterally loaded piles—properties of soil-cement mixtures—electrical resistivity—universal soil testing machine—deadman anchorages in sand—compaction of pipe bedding by vibration—vibratory compactors on granular base courses—in-place density of granular base course—plate load tests on sand—vibratory compaction of cohesive soils—microseismic.

Yosemite National Park in California is one day's journey from Los Angeles by car or train.

Santa Fe

An Invitation

INDIVIDUALS attending the Second Pacific Area Meeting in Los Angeles have been invited to inspect the laboratories and plants of these firms located in and around Los Angeles—

Consolidated Rock Products—concrete aggregates
Livingston Rock and Gravel Co., Inc.
Industrial Asphalt Co.
Douglas Aircraft
J. H. Baxter & Co.—wood treatment
Summerbell Roof Structures—glued laminated timber products
City of Los Angeles Department of Water and Power—water quality control laboratory
American Gas Assn.—testing laboratory
Rome Cable Corp.—novel method of manufacturing rigid conduit
Consolidated Western Steel
U. S. Steel Columbia-Geneva Div.
Kopper Co., Inc.—tar and chemicals
Kaiser Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Beckman Instruments Inc.—scientific and data handling equipment
California Research Corp.—oil field research and development
Richfield Oil Corp.—research and development laboratories
Shell Chemical Corp.—only completely integrated synthetic rubber plant in U.S.
Union Oil Co.—research center
All Los Angeles members of the **American Council of Independent Laboratories, Inc.**

Industry Luncheons

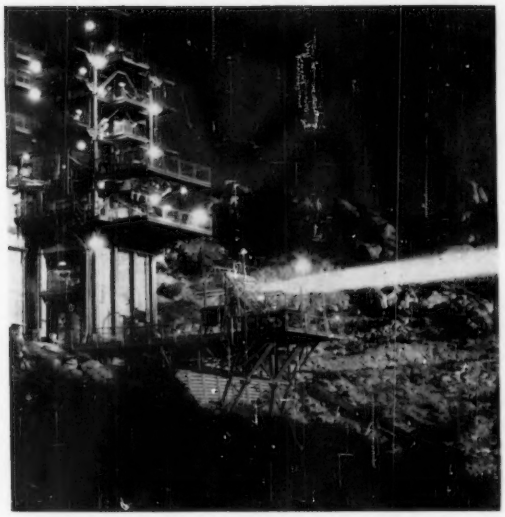
THE Industry Luncheons scheduled during the week are an unusually attractive feature of this meeting, providing as they do in a program of such tremendous technical diversity a focal point for men in the same field. At these luncheons engineers, technicians, researchers, and management in seven broad industrial groups will have an opportunity to exchange greetings, and ideas and to hear talks by leaders in the industry.

Luncheons are scheduled in the fields of:

- Soils
- Cement and Concrete
- Paint
- Petroleum
- Wood
- Water
- Railroads

Plant Visits

There are 17,000 industrial plants within a 100-mile radius of Los Angeles, a number of them new industries, others offering the most advanced facilities and techniques to be found in this country. Visits to a selected list of representative laboratories and plants in the vicinity will be arranged on an individual or small group basis by the



Rocket and jet engine testing at Santa Suzana, California field laboratory of North American Aviation, Inc.

Plant Visits Committee. They will supply the Information Desk with all needed information on hours, groups, transportation, appointments, and special arrangements. A list of companies appears in the accompanying box. More names will have been added by the time the meeting convenes.

Apparatus Exhibit

Additional attractions at the Pacific Area National Meeting include an Exhibit of Testing and Scientific Apparatus and Laboratory Supplies which is being arranged especially for the instrument makers of the far West with a substantial number of apparatus and instrument makers from the East taking part. The tenth Photographic Exhibit being held at Atlantic City will be moved complete to Los Angeles for display there. Camera enthusiasts, normally interested in landscapes, children, and grandchildren, will find themselves attracted to interesting and sometimes beautiful photographs which are a normal part of many of our industrial research and testing activities.

Information Desk

A special information committee is assisting in the preparation of advance publicity. The committee will be happy to answer specific questions about vacation opportunities and travel from those planning to combine the meeting with their vacations; it will also have an information booth at the meeting.

The February BULLETIN contained an invitation from C. M. Wakeman, Chairman of the General Committee on Arrangements. A typographical error in that invitation has caused considerable comment which only serves to reveal the interest being generated. The bus or train time required to visit Yosemite National Park and the Sequoia National Park should be one day for each trip rather than the one hour indicated. Nevertheless, this should not discourage visits—the one-day trip is well worth it to either of these famous vacation spots.

Ladies' Entertainment

For the ladies who accompany their husbands to this meeting an unusually fine social program has been arranged. High in entertainment value, the schedule will also provide the ladies who sign on for all events a unique opportunity to get acquainted with Los Angeles and all the area has to offer—the beaches, the fashionable hotels and residential sections, the movie industry, cultural institutions, California fashions, and amusements.

All this at a bargain, too. If you buy your book of tickets in advance, the total cost will be $9.75. Separately, the events will be more costly.

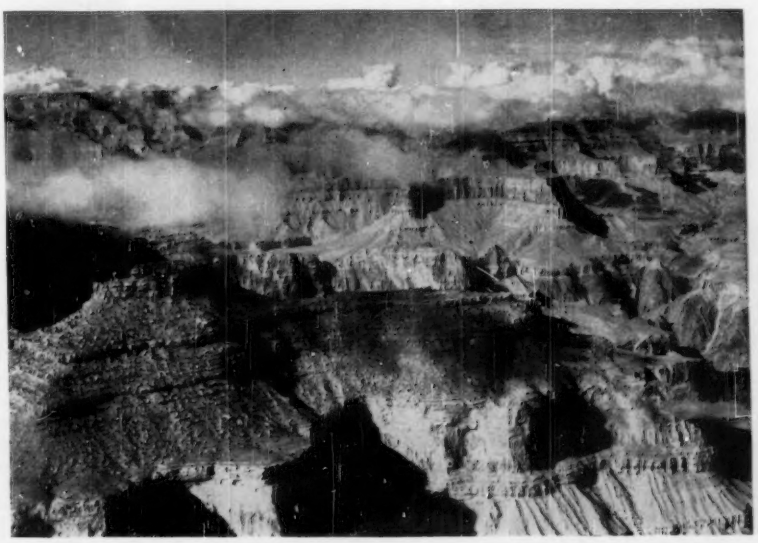
Reservations

Members are now receiving in the mails an advance registration card for accommodations at the Hotel Statler, headquarters hotel at which the sessions, committee meetings, luncheons, and exhibit will be held.

Use this card in requesting reservations and get your confirmation. A huge block of sleeping rooms has been set aside at the Statler and almost all our members will be able to be housed there. The completely air-conditioned Statler Hotel is one of the newest and finest in the country.

What could be better than a week at this fine hotel, an opportunity to attend a wide variety of technical meetings and a chance to take side trips to some of the most interesting scenery in the country adjacent to one of the fastest growing industrial centers?

If you are driving from the South or East to Los Angeles, world-famed Grand Canyon can be visited on the way.



The Henry E. Huntington Library at San Marino, California.

THE LADIES WEEK . . .

MONDAY—"Get Acquainted Breakfast" at the Statler with a Hollywood columnist and chitchat about the stars

TUESDAY—Disneyland—a bus trip to the fabulous amusement park

WEDNESDAY—Luncheon on the Ship Deck of the Sheraton-Huntington Hotel in Pasadena, the world famed Huntington Library, the beautiful estates of Pasadena, the Rose Bowl

THURSDAY—A coastline drive to Marineland, world's largest oceanarium, lunch at Marineland Restaurant, a cruise in Los Angeles harbor

FRIDAY—Wilshire Boulvard to a tour of a major film studio—a fashion brunch at the Beverly Hills Hotel and home through Beverly Hills and the homes of the stars.

Disneyland. Passengers are embarking for an Adventureland Tour of the Rivers of the World.

General Committee on Arrangements

Second Pacific Area National Meeting

Officers

W. C. Hanna, Honorary Chairman, Calif. Portland Cement Co.

Honorary Vice-Chairmen:
W. M. Barr (retired)
P. V. Garin, Southern Pacific Co.
H. P. Hoopes, Pabco Products, Inc.
E. O. Slater, Smith-Emery Co.

C. M. Wakeman, Chairman, Los Angeles Harbor Dept.
E. O. Bergman, Vice-Chairman, C. F. Braun & Co.
T. Parker Dresser, Jr., Vice-Chairman, Abbot A. Hanks, Inc.
M. B. Niesley, Secretary, Calif. Testing Labs., Inc.
Byron Weintz, Treasurer, Consolidated Rock Products Co.

Subcommittee Chairmen

Finance

Byron Weintz, Chairman
L. A. O'Leary, Vice-Chairman, W. P. Fuller and Co.

Technical Program

P. James Rich, Chairman
R. E. Davis, Vice-Chairman, University of California

Social

E. R. Millett, Jr., Chairman, Calif. Natural Gasoline Assn.
C. E. P. Jeffreys, Vice-Chairman, Truesdail Labs., Inc.

Transportation

C. W. Beardsley, Chairman, City of L. A., Bur. of Stds.
Guy Corfield, Vice-Chairman, Southern California Gas Co.

Hotels

R. B. Stringfield, Chairman
D. E. Bowers, Vice-Chairman, Gen. Petroleum Corp. of Calif.

Information

E. F. Green, Chairman, Axelson Mfg. Co.
F. J. Robbins, Vice-Chairman, Sierra Drawn Steel Corp.

Promotion and Publicity

John B. Howe, Chairman, Maurseth & Howe
T. K. Cleveland, Vice-Chairman, Phila. Quartz Co. of Calif.

Plant Visits

F. B. Doolittle, Chairman, Southern California Edison Co.
Harry Welch, Vice-Chairman, Western Precipitation Corp.

Industry Luncheons

L. L. Whiteneck, Chairman, Long Beach Harbor Dept.
C. R. Baker, Vice-Chairman, Pacific Tube Co.

ACR Notes

Administrative Committee on Research

Research on Research

By H. K. Nason[1]

Time was when "research" was a reasonably definitive term; it meant the investigation of a problem in some phase of natural science through application of the scientific method of reasoning. The dictionary still signifies it by such a connotation: "Critical and exhaustive investigation or experimentation having for its aim the revision of accepted conclusions, in the light of newly discovered facts." Alas, the application of the process thus defined to the subject would necessitate revision of the very definition. *Quantum mutatus abillo.*[2] Rather like the weasel that swallowed itself.

In words we have discovered a fertile area for application of our national mania of faddism, and already many useful old friends have met the ultimate fate to which faddism always leads—exhausted oblivion. "Research" is the latest discovery of the word hucksters, and already this venerable and useful old term is being sucked dry like a winter orange, soon to be discarded by the wayside, a withering shell. Yes, "research" is being so hacked about that soon it will have little residual preciseness. We have psychological research, philological research, business research, motivation research, consumer research, producer research, purchasing research—even artistic research! Nearly anyone who goes to the library to look up an ancient king considers himself a researcher—and considers the process of cracking a book research.

Fortunately (I think) we are a little old fashioned in ASTM. We are a research society, we operate in the physical sciences, and when we say "research" we really mean *research*. We experiment, we investigate, we criticize (and exhaust), and we revise. We seldom (we hope) let an accepted conclusion stand in the way of newly discovered fact. Herein lies our strength, and in the direct application of research to all of our activities lies our uniqueness among the technical societies.

Yes, each one of our committees uses, and always has used, research intensively, intimately, and unremittingly. Each test method, each definition, each specification is the result of research in all its phases as defined above. Research is an old business with us, and one so respected that we take it as a matter of course, without a second thought.

As our work has become more complicated, however, we have begun to differentiate our research efforts, just as have industry, Government and the scientific institutions. In most of our committee work we still do "project research" predominately. We standardize conditions, compare results, and eventually arrive at methods which are duplicable and reliable. We are concerned with isolating and fixing variables to the end that the tester in Abadan obtains the same reliable result as the one in Ponca City.

In the course of our project research, however, we nearly always turn up questions we cannot answer. Many such questions are of considerable importance, but if, as is usually the case, they lead off at an angle from the path to the immediate objective, their pursuit generally is left to another time and another team of mind-and-hand. Such problems are rich ore for "basic research"—or whatever you may want to call it. In the exploration of such paths lies great promise, and from such work will come our improvements for the future.

Sometimes these "basic" questions are so important and so pertinent to the specific project in hand that their investigation cannot be deferred. In one such case, for example, our Committees on Plastics and Electrical Insulating Materials encountered some difficulty in standardizing the impact test for relatively brittle materials. The question "what are we really measuring" seemed somewhat heretical, but pursuit of it showed that for certain materials good old Charpy and Izod readings were to a high degree measuring *density* of the specimens.[2] A considerably larger percentage of the energy absorbed was used to toss the broken specimens across the room than was used to break them. From this, the search for a more basic understanding of impact broadened and took diverse paths, many of which are still being followed avidly. But also from this and related studies came both better tests for impact strength and better understanding of the engineering properties of the materials in question.

As the number and complexity of such problems has increased, many of our technical committees have found it helpful to establish research subcommittees to insure their receiving attention. Some have sponsored study of such problems at industrial, Government, or institutional laboratories, and some have participated in an advisory capacity for the guidance of such studies sponsored by others. In some cases, ASTM committees have joined with representatives of other societies in joint research projects, and the results have been of great value. Numerous examples in boiler feedwaters, metals, plastics, and rubber could be cited.

In general, our problems are receiving attention, with both "project" and "basic" research being done or sponsored by the technical committee or committees concerned, and this is as it should be. In some cases broader participation by the Society is needed, and occasionally intersociety action is required. Ideally, the Administrative Committee on Research would serve only to coordinate and observe. In practice, ACR in the past has served additional useful purposes in detecting areas deserving attention, publicizing these, stimulating action, and, to a limited extent, sponsoring work of more than specialized interest.

Paradoxically enough, ACR will be functioning most effectively when it has nothing at all to do, for when that day arrives each technical committee will be covering its assigned field completely with both project research and basic research—experimenting, investigating, criticizing, and revising in the light of its newly discovered facts.

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[1] Director of Research, Organic Chemicals Div. Monsanto Chemical Co., St. Louis, Mo. Member of ASTM Administrative Committee on Research.

[2] Stuff like this appears in philosophical discussions to show how wise the author is. If you don't understand it, read on; you won't miss a thing. As a matter of fact, the present author admits he isn't sure he understands it either. *Lucus a non lucendo.*

ASTM Bulletin

MAY 1956

NO. 214

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

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The Federal Government has actively participated with ASTM in research and development of standard specifications and methods of test for materials for more than 50 years. Many Government departments have contributed to and benefited from the work of the Society through official representation on technical committees. They have also referred drafts of Federal specifications for material to the Society for technical review and comment. In addition many individuals in Government service hold personal membership in ASTM and serve as individuals on committees. This has resulted in an exchange of information and close similarity between many ASTM specifications and methods of test and Federal specifications.

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1955 Proceedings

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Very truly yours,

L. C. WHITMAN,
Development Engineer
DT Advance Product Engineering
General Electric Co.

A. L. SCHEIDELER,
Dielectric Phenomena
High Voltage Laboratory
General Electric Co.

The Perkin Centennial

THE PERKIN Centennial, including the 1956 National Convention of the American Association of Textile Chemists and Colorists will be held at the Waldorf-Astoria, New York City, the week of September 10, 1956, commemorating the discovery of aniline dyes.

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The session is being held as a part of International Day which is being sponsored by the American Standards Assn. and the International Organization for Standardization.

All persons registering for the Centennial will be welcome to attend.

ASTM Student Membership Award Plan Stimulated by District Councils

WITH RECENT stimulation of the ASTM Student Membership Award plan by many District Councils, the number of 1956 awards totals 165 at 32 engineering schools throughout the country. A list of schools where awards have been established, together with sponsors, follows:

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Purdue University	C. H. Fellows
Iowa State College	Hugh Bigler
Worcester Polytechnic Inst.	S. Collier
University of Detroit	Detroit District
University of Michigan	Detroit District
Wayne University	Detroit District
Princeton University	Philadelphia District
Rensselaer Polytechnic Inst.	R. J. Painter
University of Akron	Cleveland District
Case Institute of Technology	Cleveland District
Fenn College	Cleveland District
Ohio Northern University	Robert S. Armstrong
University of Toledo	C. R. Muenger
University of Oklahoma	Cecil Armstrong M. E. Holmberg (Southwest District)
Bucknell University	Philadelphia District
Carnegie Institute of Technology	Pittsburgh District
Drexel Institute of Technology	L. P. Mains (S. J. Leonard Memorial) Philadelphia District
Lafayette College	Philadelphia District
Lehigh University	Martin Mahler Philadelphia District
Pennsylvania State University	Pittsburgh District
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The Northern California District Council on President's Night. Back row: M. Sahlberg, W. W. Moore, B. Nishkian, G. J. Grieve, H. de Bussieres, W. N. Lindblad, R. C. Vollmar, E. W. Gardiner, R. C. Henning, R. A. Kinzie, Jr., C. F. Lapier, and R. W. Harrington. Front row: L. A. O'Leary, D. Finley, T. P. Dresser, Jr., President C. H. Fellows, Executive Secretary R. J. Painter, H. P. Hoopes, P. E. McCoy, P. V. Garin, and R. E. Davis

District Activities

President Visits Northwest and Canadian Groups

FOLLOWING the San Francisco Meeting in March (notes on previous meetings attended by the President on his western trip were on page 31, April BULLETIN) Mr. Fellows and Executive Secretary Painter went to Salt Lake City and thence to Richland, Spokane, Portland, and Vancouver, returning East to Toronto as a part of their 10,000 mile trip.

At each of these meetings President Fellows gave his talk on "Research in the Electric Power Field," which was well received in each city. Executive Secretary Painter spoke briefly, usually as a coffee talk, on some topic involving research and standards in materials, and referred each time to the importance of stimulating interest in engineering education.

The **Salt Lake City** meeting, held at the University of Utah, was a joint one with the Utah Section of ASME. In the absence of Messrs. Hogan and Jenike, the chairman and vice-chairman, Donald L. King of Eimco Corp., who is ASME secretary, presided, and introduced the ASTM officers. Although the attendance was not large, there was a good representation from engineers and technical people in varied categories.

The **Richland, Wash.,** meeting which continued unbroken the yearly visits in recent years of ASTM presidents, was again a joint one with five other societies in the Richland or Columbia Valley area, including ASM, ACS, AIChE, AIEE and the Instrument Society. (ASME was having a local section meeting that night to hear their president, Dr. Joseph Barker. It was of interest that three national presidents crossed each other's trails on several occasions—A. O. Schaefer, The Midvale Co., ASM president, was also in the West.)

About 125 were present at the Richland Junior High School when W. R. Smith, ASM chairman, opened the meeting. The technical chairman was Richard Brouns. John Rector, ASM vice-chairman, had arranged this meeting and Roy Hoffman of AIEE was host to Messrs. Fellows and Painter. Preceding this meeting was a joint dinner with ACS, at which A. H. Greager, engineering manager at Hanford, spoke on the "Worth of the Technical Man."

The **Spokane** meeting, the first that ASTM has held in this expanding area, was arranged by John C. Cook, owner of the Washington Testing Laboratories. He had elicited the support of a number of local chapters of other groups including the Washington Society of Professional Engineers, the Spokane Technical Council, and ACS, AIEE, ASME, AIME, ASCE. Following a social hour, sponsored by Herbert Sullivan, Central Pre-Mix Concrete Co. and Union Sand and Gravel Co., was a musical period with selections by the Spokansmen, a fine quartette obtained by Mr. Cook.

At Richland, left to right: Carl F. Falk, chairman, Columbia Valley Section, AIChE; A. M. Platt, vice-chairman, AIChE; ASTM Executive Secretary Painter; Milton Lewis, chairman-elect, Richland Section, ACS; O. H. Greagor, acting manager, Engineering Dept. of Hanford Atomic Products Operation; ASTM President Fellows; Roy Hoffman, program chairman, Richland Section, AIEE; W. A. Richards, president, Richland Section, ISA.

The accompanying photograph shows the men at the head table including the ASME President, Dr. Barker, who spoke in Spokane on the following Saturday night. There were about 75 at the ASTM meeting. President Fellows was introduced by E. W. Greenfield, Kaiser Aluminum and Chemical Corp., who is active in ASTM committee work.

A very active ASTM member, W. B. Kirby, chief engineer, Electric Steel Foundry Co., arranged the **Portland** meeting jointly with the Oregon Chapter of ASM, on Tuesday, March 27, at the Washington Hotel. J. E. Gustafson, Bethlehem Steel Co., presided.

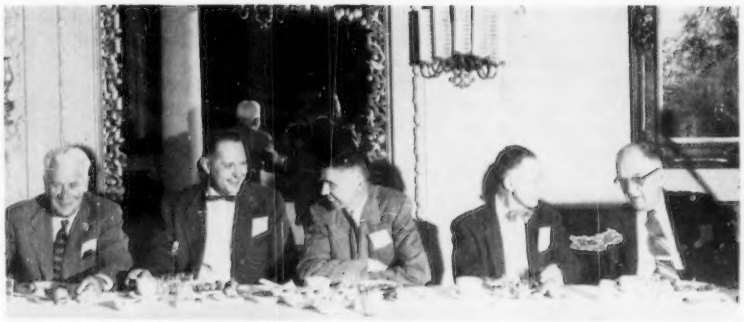
The Portland area, like so many industrial centers in the West, is growing, and it is hoped that additional meetings can be held when the Society's President visits the West. Among those at the meeting were such well-known ASTM members as T. K. May, West Coast Lumbermen's Assn., and S. H. Graf, a longtime member and for years head of chemical engineering at Oregon State.

Crossing into Canada, the officers held the first technical meeting of ASTM in Vancouver in cooperation with the Vancouver Section, Chemical Engineering Division, Chemical Institute of Canada, and Vancouver Section, National Association of Corrosion Engineers.

Gray Walrod arranged the program and meeting details in excellent fashion. Dr. Lester Shemilt of the University of British Columbia, presided. During their stay, the ASTM officers attended a faculty luncheon on March 29, at the university with President MacKenzie and Engineering Dean Gunning.

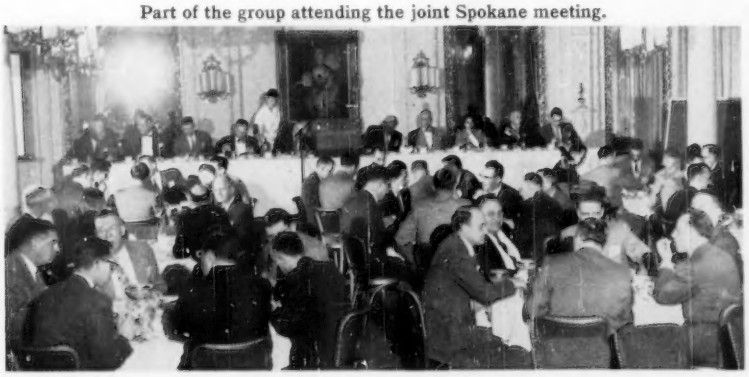
Entraining for the East on Easter Sunday, April 1, the party arrived in Toronto for a luncheon of the Western New York-Ontario councillors and a trip to the Approval Laboratories of the Canadian Standards Assn. Here extensive evaluation and testing of a variety of products is carried out with some very interesting special facilities and performance tests. District Vice-Chairman G. J. Gaukroger presided. CSA Public Relations Manager, A. F. Telfer and Jerry Moes, Director of the Laboratories, were hosts.

During this trip the officers made many significant contacts with our members and those concerned with the work. Everywhere there was evidence of keen concern with what ASTM is doing in the field of materials and throughout the trip the many courtesies and the gracious reception at every point was deeply gratifying to the officers.



The Spokane dinner meeting. Top, left to right: Herbert Sullivan, Harold Martindale. AIEE; Edward Atwood, WSPE; E. W. Greenfield, ASTM, and President Fellows, ASTM, Below: John C. Cook, ASTM; Executive Secretary Painter; Lydia Savedoff, local ACS president; ASME President Joseph Barker; and Ralph Landerholm, local ASME chairman.

Part of the group attending the joint Spokane meeting.



CHICAGO

CONSIDERABLE discussion of President Fellows' address to the Chicago District members and their friends, including representation from Western Society of Engineers, American Institute of Electrical Engineers, and The American Society of Mechanical Engineers, on Wednesday, April 11, centered about the use of overhead aluminum conductor cable for high-voltage as well as the use of similar cable for underground use. One of the big problems as yet unsolved is a satisfactory method of joining aluminum to aluminum and aluminum to copper. President Fellows, as in his other District addresses, covered various aspects of research work under way in Detroit Edison Co., including wood preservation, corrosion of galvanized steel transmission towers, tree growth control, fish fences, insulating oils, and nuclear power in addition to the high-voltage aluminum cable.

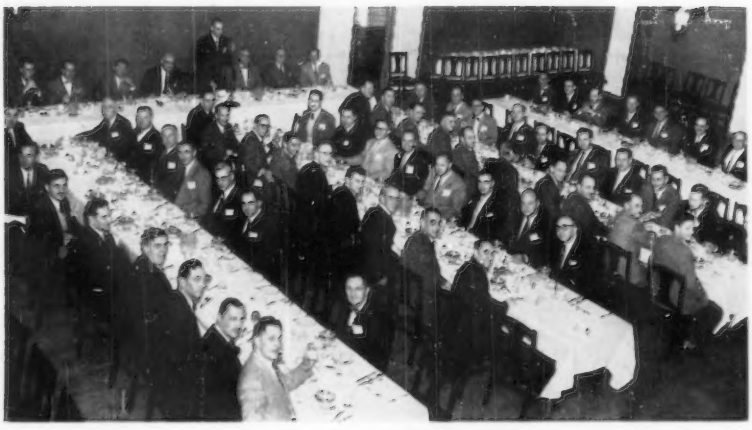
Mr. Fellows, who was the guest of honor at the dinner sponsored by local council prior to the meeting, was introduced by J. J. Kanter of the Crane Co., a Chicago District Councillor and

longtime friend of the President. Mr. Kanter commented on the fact that Mr. Fellows had been the first chairman of the Administrative Committee on District Activities and as such takes a particular interest in the activities of the various Districts.

Prior to the President's address, W. L. Bowler, Vice-Chairman of the Chicago District acting in the absence of Chairman H. P. Hagedorn, introduced A. P. Boysen, President, WSE; and J. S. Pettibone of the Headquarters Staff. Mr. Pettibone commented briefly on various current aspects of the Society's work and particularly the activities of Districts other than the sponsoring of meetings. Specific examples are participation in science fairs, cooperation of the Southern California and Southwest districts with the Advisory Committee on Corrosion, and the fact that the Philadelphia, Detroit, Pittsburgh, New England and Cleveland Districts are sponsoring student membership prize awards.

The arrangements for the meeting were made by Messrs. Bowler and C. W. Muhlenbruch, Chicago District Secretary.

At Vancouver. Top, left to right: John McLaughlin, NACE; John Hurley, ASM; Frank Mitchell, local NACE chairman; and ASTM President Fellows. Right: Lester Shemilt, University of British Columbia; R. J. Painter, ASTM Executive Secretary; Donald Morrison, M. G. Walrod, program chairman. Below: a general view of the dinner group at Vancouver.



NEW YORK

Speaker Scores "Science Fiction" View of Plastics

AT THE joint meeting of the New York District of ASTM and the Society of the Plastics Industry on April 17, an audience of about 80 members of the two societies and their wives enjoyed a very interesting talk entitled "Plastics—Science Fiction or Practical Facts" by W. J. Connelly, assistant director of public relations, Bakelite Co. In an excellent presentation with many visual aids—charts, demonstration apparatus, slide projectors, and a motion picture projector—Mr. Connelly related some of the almost unbelievable developments in plastics from their earliest beginnings. He mentioned the confusion that has continued throughout the years on the true picture of the scientific contributions in plastics and the claims made for plastics which border on the unbelievable.

"While some in modern times have looked upon the plastics industry through the eyes of the science fiction writer, particularly in the late '30's and early '40's," said Mr. Connelly, "there are less and less who see the plastics industry through rose-colored glasses. Instead, as if viewing it through the modern scientist's microscope, the industry comes sharply into focus as an important and permanent part of our modern economy.

"As the chemist, the engineer and the production man link molecules together into complex chains to produce plastic resins and compounds, so too, do they link specific properties into the material and tailor-make their products to specifications. 'Ah,' said the science fiction writer, 'just what I wanted to know' and forthwith he wrote something like this: 'Plastics are now going to be lighter than aluminum, clearer than

Members of the Cleveland District Council at the recent District meeting. Left to right: Earl Smith; Edward Dyble; A. L. Boegehold, the speaker of the evening; L. F. Herron, District Chairman; H. D. Churchill, District Vice-Chairman; J. S. Pettibone, ASTM Staff; and R. T. Bayless.

glass, stronger than steel and cheaper than dirt!'

"That's science fiction based on scientific fact but incorrect because the impression is left that all plastics are going to be all of those things at one and the same time. Had the science fiction writer not said it in his all-inclusive way, he would have been 100 per cent right. Most plastics are lighter than aluminum, there are some clearer than conventional glass and there are some that can be stronger than steel on a weight strength ratio . . . and have any of you tried to buy any topsoil lately?

"However, there is no *one* plastic material that will do all things for all people. . . .

"The plastics industry," continued Mr. Connelly, "is the first to disclaim the label 'cure-all' for plastics. The industry looks upon plastics as materials which will do two things: they can bring specific properties that are not found in conventional natural materials, and they can and do serve to assist, augment, and enhance natural materials in doing a better job."

Following his talk, the audience kept Mr. Connelly for an extended and lively discussion.

H. C. R. Carlson introduced the speaker of the evening and conducted the discussion. Langdon R. Williams, Director of Public Relations for SPI, was present to make a few remarks to the group on behalf of SPI.

CLEVELAND

FOLLOWING a social hour and dinner attended by more than 150 members and friends of the ASTM Cleveland District, Alfred L. Boegehold, manager of the research staff activities of the Research Division, General Motors Corp., spoke on "Materials for Automobiles of the Future." He discussed the relative advantages of different types of power plants (including the conventional piston gasoline engine as a base line); the piston gasoline engine of still higher compression ratios, that is, on the order of 12 to 1; and the use of light materials of construction for increasing the power-weight ratio. This greater use of the light metals is shown in the fact that an average of 30 lb of aluminum was used in 1955 models and 35 lb in the 1956 models. It is predicted that by 1980 the average weight of light metals used will be 200 lb per car. At the present time the Cadillac Eldorado contains 192 lb. Mr. Boegehold pointed out that one of the common light metals readily available is magnesium, found in sea water to the extent of 0.12 per cent. One cubic mile of sea water could produce 175 lb of magnesium for each of the 52 million cars currently on the roads today.

As compared with 52 million cars registered now it is expected that by 1980 there will be 84 million; average horsepower will be 250 and average gasoline consumption will be 30 mpg at 40 mph.

Student Membership Awards

Prior to Mr. Boegehold's talk, L. F. Herron, The James H. Herron Co., Chairman of the ASTM Cleveland District, presented student membership prize awards to 14 students who were guests of the District Council at the dinner meeting. In addition to the 14 there were seven others who were unable to attend. Of the 21 recipients nine were from Case Institute of Technology, nine from Fenn College, and three from the University of Akron.

Cleveland District Student Membership Award winners: Back row left to right: D. R. McRitchie, T. G. Spofford, G. H. Griffin, *Case Institute of Technology;* **R. C. Bryan,** *University of Akron;* **B. S. Daniels, S. E. Lassa, R. F. Neff,** *Fenn College.* **Front row: J. S. Fox, T. A. Blanchard, W. F. Franklin,** *Case Institute of Technology;* **Miss M. R. Stevens, J. T. Kotnik, C. B. Melton, J. R. Hydock,** *Fenn College* **Unable to attend were: Miss Stefania C. Ausenek, W. J. Sheak,** *Fenn College;* **G. F. Davis, D. H. Murray,** *University of Akron;* **R. M. Altemus, F. E. Hardgrove, R. D. Lesher,** *Case Institute of Technology.*

Technical Committee Notes

Natural Building Stones

Committee Sees Durability as Most Important Property

DURABILITY of natural building stones—the most significant property required for satisfactory service in building construction—was emphasized at the meeting of Committee C-18 held in Washington, D. C., on April 13. An excellent attendance at the meeting indicated a renewal of interest on the part of the membership in the activity now under way for the development of specifications on each type of the most commonly used natural building stones.

Reports were presented from several of the Task Groups which were recently organized to develop specifications for granite, marble, limestone, sandstone, and slate. It is felt that there is a definite need for specifications and that the physical characteristics recognized should be related to structural durability. The task groups will study those physical characteristics having reasonable correlation with service. It was suggested that additional task groups might be considered to work on standards for soapstone and greenstone.

The Task Group on Granite proposes to classify projected specifications according to usage, such as engineering, architectural and landscape use. A significant fact already determined, indicates that the compression test is the only test to date which has shown real possibilities of correlation with service.

The Task Group on Marble has found that chemical decomposition tests show some merit for use with calcium stones and that grain size and flexibility characteristics are significant.

The Task Group on Slate is planning to submit a specification to the committee within the year.

Chairman Currier's Remarks

Excerpts from the chairman's remarks to the committee appear below:

To quote from the charter of the Society, "The corporation is formed for the promotion of knowledge of the materials of engineering and the standardization of specifications and the methods of testing."

By *specification* is meant a statement of particularization whereby the selection, quality, and use of material may be controlled.

As to materials of engineering, we are concerned only with the natural building stones and their uses in dimensional forms as opposed to crushed stone. Further, it is desirable to discriminate between exterior and interior uses, so that separate and appropriate specifications may be written for all structural purposes. The present task, however, is to write specifications for only exterior stone.

The term "classes" will be used in the sense of principal lithologic groups, with no close discrimination between technical and petrographic varieties within the classes. The classes with which we are concerned at this time are *granite, sandstone, limestone, marble, slate.* The extent to which we may concern ourselves in our present studies with subdivisions of these classes is to a considerable degree discretionary with the various work groups. For example, the commercial granites are defined to include many petrologic rock types—granite, syenite, morzonite, *et al*—yet it would be impracticable and unnecessary to write separate specifications for these. However, the work group might conceivably recommend separate treatments for some groups, as for example, the so-called "black granites." Similar reasoning applies to other classes. We should avoid, so far as possible, breakdowns of the major classes. In particular we should certainly avoid separate or special treatments of district or trade varieties. On the other hand, if study reveals that the inclusion of broad types, such as "black granites," quartzites, serpentine marbles, *et al*, in their respective class specifications materially weakens the specifications or generalizes them beyond practical value, such types should be dealt with separately.

We shall confine our specifications strictly within individual classes. It is not in the province of specifications to favor one class more than another, or in any way promote a competitive attitude between classes. Comparisons of this sort should be avoided. Obviously, rocks of all the principal classes have been used successfully through the ages. Advice as to appropriate uses and modes of construction may well come from the separate fields concerned. In this direction both the producer and consumer may furnish valuable experiential factors.

We have adopted standard definitions (C 119-50) for the major classes of stone and it would be desirable to use them as the basic guide. Nevertheless, if need arises through our work on specifications, modifications or revisions of these definitions may be recommended. In other words, the definitions should serve rather than control the writing of specifications. If revisions or additional definitions are needed, the matter should be particularized and brought to the attention of the subcommittee on nomenclature and definitions.

The promotion of knowledge of the materials of engineering" is a liberal phrase. It could lead us broadly afield from our specific objective. By the same token it is a stimulant to research that could have direct and practical bearing on the problem of specifications. It would be salutary, indeed, if our immediate work will serve additionally to point up research that is needed in the field of natural building stones. The scope of our work, then, includes not only recognition of the needs for further studies in the field of building stones, but recommendations as to appropriate paths of research. The more we know about the occurrences, characteristics, and properties of stone, the more able we become in the writing of practical specifications.

Structural Sandwich Constructions

Physical Properties and Durability Main Topics of Discussion

THE PHYSICAL properties of both structural sandwich core material and the sandwich construction itself, as well as durability, were the principal subjects of discussion and action at the meeting of Committee C-19 held at Wright-Patterson Air Force Base on April 18 and 19. The Materials Laboratory was the host to the committee which had an unprecedented attendance of close to 100 members and guests at the meeting.

The significance of an impact test on core material alone was discussed at some length and the need for a standard test expressed, although such a test should be tied in with the impact testing of sandwich construction. A draft of a proposed method will be prepared for subcommittee review. Sufficient interest was shown to warrant the preparation of a water (fluid) migration test. The all-metal type of sandwich core

material has provided the newest problems for study, especially in evaluation at elevated temperatures.

The characteristic which has probably received the most attention in the Subcommittee on Basic Sandwich Construction has been the measurement of peel. Three test methods have been under consideration: the Martin, rotating drum, and FPL climbing drum tests. Drafts of the three methods will be balloted upon in the subcommittee to determine which method should be promulgated. It was pointed out that Committee D-14 on Adhesives was also developing a test method using the climbing drum procedure. A draft copy of a proposed test for measuring flexure-creep loading will be circulated for subcommittee letter ballot. No definite consensus was obtained from the circulation of a questionnaire on four types of impact tests: (*a*) the ball mill, (*b*) use of flat weights on flat specimens, (*c*) flat drops of successively larger weights followed by a compression test, and (*d*) the use of a 1-in. diam cylinder at successively higher drops. A revised draft of a method utilizing the cylinder with hemispherical ends hitting on a flat disk will be prepared for further study. One other test method under consideration is the stub meter test on which data are being collected on a number of samples at the Wright Air Development Center and at the Forest Products Laboratory.

An interesting discussion took place at the meeting of the Subcommittee on Permanence, Durability, and Simulated Service. The activity of this subcommittee is concentrated on the use of two ASTM exposure test sites, at Penn State University and at Kure Beach, N. C. Samples of various types of sandwich construction which have been exposed for one year will be tested in flatwise flexure and edgewise compression tests.

A fatigue test was given considerable attention. Work is getting under way at WADC using vibrating equipment with a free beam mounting. A draft of a plate shear fatigue test developed at FPL will be distributed for subcommittee letter ballot. The subcommittee endorsed the use of the cycling test for laboratory aging procedure as now included in the Tentative Methods of Test for Evaluating the Properties of Building Boards (D 1037).

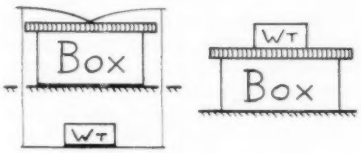
Following its meetings, members of the committee enjoyed a tour of service test facilities at WADC and a dinner at which two papers were presented by WADC men: "Tests of Sandwich Aircraft Structures" by Fred Hower and "Sandwich Program at the Materials Laboratory" by F. H. Bair.

Shipping Containers

Stacking Test Pioneered by Task Group

IN THE shipping container industry, stacking is a matter of dollars and cents. Cartons capable of being stacked mean reduction in unit storage cost over cartons which are not capable of being stacked. It has been the objective of the Task Group on Stacking to pioneer a reliable stacking test. This task group, reporting during the D-10 Meeting in Atlantic City, N. J., on April 11 and 12, has been evaluating the effects of stacking on corrugated paperboard shipping containers for the past four years. In that time two series of collaborative test programs have been completed, in which six laboratories have tested a great number of specimens. The results of these two collaborative test programs have shown conclusively that it is not feasible to determine the stacking capability of paperboard boxes based on a simulated stacking load test.

The task group then considered the work recently reported by the Forest Products Laboratory, in which deadweight load is suspended underneath the paperboard box by means of a suspending arrangement hung from a fulcrum acting on the geometrical center of a platen centered on the paperboard box. This approach permitted the simulated stacking weight to act evenly over the entire upper surface of the box, prohibiting the deleterious effects caused by an uneven distribution of weight as in the top-loading test previously investigated by the task groups. The FPL has shown that a definite correlation exists between their simulated stacking failure and the compressive strength of the paperboard container. A recommended practice for the evaluation of the stackability of paperboard containers based upon the FPL test is being proposed by the task group.



The revolving hexagonal drum tester (Method D 782) was designed to give variable falls and therefore the variable results of the test are to be anticipated. This has in fact been borne out by the extensive interlaboratory collaborative testing programs which have been carried out since 1951. The Task Group on Drum Testing expects to recommend revisions of Method D 782 on the basis of this work.

Data from a series of collaborative tests by the Vibration Test Task Group on three 1000-lb vibration testing machines were presented. These data will be consolidated and made the basis of proposed revisions of the Tentative Method of Vibration Test for Shipping Containers (D 999).

A revision of the proposed revised Standard Method of Drop Test for Shipping Containers (D 775), which tightens up the present method was presented by the Drop Test Task Group. The proposed revision includes two additional alternate procedures: safe drop height—infinite number of drops procedure and the failure zone drop-test procedure.

Progress on dynamic tests of package cushioning materials was discussed. Two methods use a guided dropping platform and a pendulum tester with an accelerometer with an ocilloscope to record the shocks (scope face data recorded photographically). This transducing and recording system is similar to that now being adopted by the automotive industry for crash panels.

Other committee work in various stages of completion includes: review of existing and newly proposed definitions on packaging, collaborative test program for the revision of Standard Methods of Test for Water Vapor Permeability of Shipping Containers (D 1008), and progress on the bibliography of available literature on interior packing.

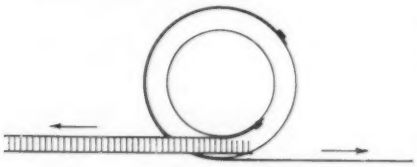
Adhesives

Peel Test Method Completed

INTEREST in metal-to-metal peel testing has been evidenced by most organizations utilizing adhesives and particularly by the aircraft industry. One of the main reasons for the interest in peel has been that the test is apparently much more sensitive to small variations of adhesion than most other tests. Such variables as processing, curing chemicals, handling of uncured bond, temperature variations, and so forth, are much more readily apparent using the peel test rather than the shear test, for instance.

During the past two years, three peel methods have been studied. Of these, the proposed method for climbing drum peel test for adhesives, was approved for submission to committee ballot during the Committee D-14 meeting in Louisville, Ky., on April 4 and 5. This test, which is designed for materials which cannot permit a back turn of

180 deg, as is the case in Method of Test for Peel or Stripping Strength of Adhesives (D 903), utilizes a flanged



drum against which one metal surface is attached. The drum is then rolled and in so doing peels one of the laminated metal surfaces from the other. The peeling torque as calculated from this test includes both the forces required to peel the adhesive bond and to bend the facing.

The primary use of creep tests is to provide basic data for the choice of safe working stresses for applications in which allowable deformation within the service life of the structure is the criterion of failure. In 1949, Committee D-14 established a section to develop a test method for this property of adhesives. The difficulties involved in this program are evidenced by the length of time this program has been under study. A proposed method for conducting creep tests of metal-to-metal adhesive bonds has now been submitted. This method is presently being used in the aircraft industry; the data of over 250 samples indicates the method's merit.

The cooperative testing program to determine the proper rate of loading to specify in Tentative Methods of Test of Strength Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal) (D 1002) for lap joint specimens was reviewed. This program, begun in 1954, now includes three types of adhesives on both aluminum and steel specimens, having overlaps of 0.5 and 0.75 in., and tested at loading rates of 200 to 1200 lb per min. In view of the difficulties in cutting these specimens from large sheets to avoid edge effects, the use of a new type cutting apparatus has been suggested to eliminate one of the most difficult problems of this test program.

Reports were also made on progress in the preparation of a specification for label adhesives, sampling of liquid adhesives in drums, and specifications for room-temperature setting adhesives. Studies are also being continued using the Hercules Tackmeter, the work on the Interchemical Corp. tackmeter now being virtually complete. A review of the current status of the chemical-physical forces involved in adhesive bonds was also presented.

The after-dinner speaker at the Committee D-14 dinner was C. D. Dosker, president of Gamble Brothers Co., Louisville. Dosker reviewed the past accomplishments in the wood-adhesive field and painted a glowing picture of the future possibilities of mechanically produced lumber using natural wood fibers.

Joint Committee on Leather Completes Organization

THE AMERICAN LEATHER CHEMISTS ASSN. and ASTM have completed the organization of a joint technical committee to develop standard physical test methods for leather. The committee was officially organized at a meeting held in Philadelphia on March 13, 1956. Officers elected at the meeting were J. R. Kanagy, National Bureau of Standards, Chairman; R. J. Wirshing, General Motors Corp., vice chairman; and M. H. Battles, A. C. Lawrence Leather Co., secretary. The 50 people who attended the organization meeting represented a cross-section of the leather industry including leather producers, consumers, and those having a general interest. The committee will be concerned with test methods for leather used in shoes, gloves, upholstery, packings, belting, etc. Its stated scope of activity is "the development, evaluation of the significance, and standardization of methods of sampling and testing and definition of terms pertaining to leather."

The committee elected an Advisory Committee consisting of official representatives from ALCA and ASTM and eight other members representing producer, consumer, and general interest groups. Officers of the committee will serve also as officers of the Advisory Committee. Other members are:

R. G. Asheraft, Endicott-Johnson Corp.
A. N. Kay, Howes Leather Co., Inc.
B. L. Lewis, Tinius Olsen Testing Machine Co. (ASTM representative)
Mieth Maeser, United Shoe Machinery Corp. (ALCA representative)
G. H. Meyer, Liberty Dressing Co.
R. Shaw, Rohm and Haas Co.
J. N. Smith, E. F. Houghton and Co.

The committee approved the formation of five working subcommittees on the following subjects:

I Nomenclature, Definitions and Applicability (of Tests)
II Sampling and Conditions for Physical Testing
III General Physical Testing
IV Research
V Editorial

The committee will work initially on a number of test methods developed by the American Leather Chemists Assn.

A. G. Scroggie

Scroggie Honored by Textile Committee

ARTHUR G. SCROGGIE, seventh recipient of the H. deWitt Smith Medal, received this honor from ASTM Committee D-13 on Textiles on March 15 during the spring meeting of the committee in New York City.

The Smith medal, commemorating the man who pioneered the concept of an engineering approach to properties and utilization of textile fibers, is awarded for outstanding achievement in fiber research and use. It is endowed by Fiber Research Laboratories, Inc., of Boston.

Dr. Scroggie is manager of the Characterization Laboratory of the Textile and Industrial Products Research Division of the Textile Fibers Department of E. I. du Pont de Nemours & Co., Inc., at Wilmington, Del. He has a long and distinguished record of service in ASTM as well as other technical and scientific societies. A member of Committee D-13 since 1928, he has been a very active member of a number of its subcommittees and task groups. From 1944 to 1948 he served as vice-chairman of D-13.

Identify Your Piping System

ON JANUARY 27, 1956, the American Standards Assn. approved for publication the American Standard Scheme for the Identification of Piping Systems (A13.1–1956). The eight-page booklet is being published by The American Society of Mechanical Engineers.

This scheme represents the application of a simple color principle to the solution of a problem that appeared beyond the possibility of accomplishment to many engineers. Of particular interest to ASTM members is the fact that the ASTM representatives on the ASA committee were able to contribute materially in offering the original color concept upon which the scheme is based.

COMMITTEE D-7 ON WOOD

ASTM Wood Pole Research Program

PROGRESS REPORT NO. 4

THE ASTM Wood Pole Research Program, which has now been in progress for two years, was developed to get answers to a number of vital questions of importance to wood pole producers, treaters, and users. The questions relate to the strength of poles of different species, factors affecting strength, simplified methods of establishing fiber stresses, methods of testing for strength, and need for revision of pole specifications.

Broadly, the basic objectives of the program are:

- To obtain reliable data on the strength of full-size poles of different species to provide a basis for establishing the most economical size classes, design stresses, and specification requirements.
- To determine the effects of preservative treatments upon the strength of poles.
- To establish a correlation between the strength of small clear specimens and full-size poles in order to render it unnecessary in the future to make expensive tests on full-size poles.
- To study the reliability of the machine *versus* the crib method of testing full-size poles, and to compare the results obtained from them.

Expected results of the program are more precise information that will reduce the "ignorance factor" in pole design and pole safety, more accurate means of rating poles for strength, and a method of more quickly and economically establishing the actual strength of new species for poles, with anticipated annual savings to pole users amounting to many times the cost of the program.

The complete program includes southern yellow pine, western red cedar, lodgepole pine, Douglas-fir, and western larch, and involves tests of some 600 full-size poles and over 15,000 tests of small clear specimens. The total cost, as presently outlined, is $254,000.

The research program is developed on the basis of contributions from interested organizations and agencies and is under the supervision of ASTM Committee D-7 on Wood. The research is being carried on by the ASTM through the cooperation of the U. S. Forest Products Laboratory.

Research Progress

Substantial progress has been made in carrying out the program since the research was started two years ago, and with the completion of the tests on the untreated poles and the reports relating thereto, the work is about one-half completed. More specifically, the tests have been completed on untreated western larch, Douglas-fir, western red cedar, lodgepole pine, and the four species of southern yellow pine to determine the strength of the several species and the relationship of pole strength to the inherent strength of the wood. In addition, a number of full-size southern-yellow-pine poles were tested to compare the two standard test methods. Altogether there have been tested some 306 full-size poles and several thousand matched clear specimens. This completed the testing of what were designated series I and series II in the original plan of the program. The remainder of the program covers the study of poles that have been pressure-treated with wood preservatives (series III), and the over-all analysis and integration of all the data as a basis for revising specifications and establishing strength classes.

Although, as indicated, specific recommendations regarding changes in specifications and fiber-stress ratings for pole species must await the completion of the study, interim reports with detailed data from the tests are issued to all contributors and committee members as the work progresses. Reports on untreated larch, Douglas-fir, and southern pine poles have already been distributed. Reports on untreated lodgepole pine and western red cedar poles and the report covering a comparison of the machine and crib methods of test are nearing completion and will be issued within the next few months.

The number of tests made and the extensive data presented in the interim reports reflect the extent and importance of the results obtained, and yet even these are not a complete measure of the progress made. An extensive body of general knowledge on the characteristics of wood poles is being accumulated. A few of the highlights in this new body of knowledge follow:

Experience in the collection of untreated poles for test has borne out the wisdom of the sampling plan specified for the test poles. It was early recognized that the more extensive testing involved with pure random sampling of the test material would make the amount of work and the related cost prohibitive. A special procedure was designed for this project to take full advantage of existing information on the strength properties of the various species of wood from the thousands of standard tests of small clear specimens which have previously been made. The plan recognized the relationship of strength to specific gravity and called for the larger part of the sample to be taken from poles of average gravity for their species. Experience in selecting poles has shown that poles of average specific gravity can be obtained with little difficulty. While some trouble was encountered in finding poles of extremely high or extremely low specific gravity a sufficient range has been found to confirm the relationship of the strength of a pole to the density of the wood. The contemplated comparisons of test groups by matching rather than randomization has a sound statistical basis. It is essentially a comparison based on pairs of values in which experimental error is reduced by eliminating the variability due to specific gravity.

The relation of strength to specific gravity in poles has suggested the possibility of an improved method of selection of poles for strength. A field method of determining specific gravity from increment borings has proved rapid and reasonably accurate. It is possible that such a method could be applied to poles in commercial production. The increased selectivity of strength obtainable in this way would permit higher stresses on the stronger poles without sacrificing any of the factor of safety needed in the weaker poles. A possible alternative in species like southern pine and Douglas-fir in which summerwood is

well defined from springwood is to apply a "density rule" based on the estimated proportion of summerwood and the rate of growth. Such a rule has been used successfully for many years with structural lumber, and preliminary analysis of the pole test data indicates that it is practical there also.

The comparison of the two standard test methods has shown that no essential difference exists except in the case of the largest poles. Where a pole is of such size and length that its own weight may cause an appreciable stress, the two methods give somewhat different results. It is planned to use the cantilever method in subsequent tests of treated poles of large size.

Experience in the testing of poles by both machine and cantilever methods has suggested some modification in the methods of test. These are incorporated in recent revisions of "Tentative Methods of Static Tests of Wood Poles," D 1036–55 T.[1] The revisions include a practical method for relating the stiffness of a pole to the modulus of elasticity of the wood, a method newly developed in this program.

Data on the effects of natural characteristics on the strength of wood poles are being accumulated. It is found, for example, that knots in the upper portion of the length of a transmission pole have little or no effect on the strength. Studies of poles with spiral grain show that its effect on strength is much less in a pole than in a sawed structural timber.

Some of the technical questions raised in the program are still open. More needs to be learned of the effect of the seasoning of poles on their strength. Poles in the test program have been in the green condition for closer comparison among species; at the same time, it is recognized that poles in service may receive a considerable amount of seasoning above the groundline. This is particularly important in a species like lodgepole pine which is generally used in the drier climates. Additional work correlated with the ASTM Wood Pole Research Program has been suggested.

The selection of test poles for treatment is now going forward. Southern pine and Douglas-fir poles have been selected and treated. Tests are already under way on some of the test material that has been received at the Forest Products Laboratory. Plans for the selection of poles for treatment in other species are being developed.

Financial Support Shared

The financial support accorded this comprehensive program by a large number of organizations and individuals has been most encouraging and is acknowledged with thanks and appreciation by the ASTM. However, the program as outlined is not yet completely underwritten, so that the committee continues to invite contributions.

A cordial invitation is again extended to participants and others interested in the program to visit the Forest Products Laboratory at Madison to witness the pole tests while the program is still in progress. Since the testing will be somwhat intermittent, it is suggested that advance arrangements be made to insure that tests of full-size poles will be under way at the time of the visit.

[1] 1955 Book of ASTM Standards, Part 4, p. 935.

MIT Will Promote Molecular Engineering in Summer Program

A TWO-WEEK Special Summer Program on so-called Molecular Engineering, from August 20 through August 31, will be a part of the 1956 Summer Session at the Massachusetts Institute of Technology. According to E. H. Huntress, Director of the Summer Session, the Program should clarify outstanding issues by precipitating a vigorous clash of opinions in round-table conferences.

The Program, which will be under the direction of Professor Arthur R. von Hippel, Director of the Laboratory of Insulation Research at MIT, is designed for engineers and scientists generally.

According to Professor von Hippel, molecular engineering is the mode of thinking about engineering problems "from the inside," by discerning the elementary particles and their interplay in gases, liquids, and solids. Its development and practice require a true alliance between engineers and scientists—an alliance in broad thinking unhampered by departmental boundaries of specialization. If materials with desired properties can be designed and the phenomena steered judiciously by an understanding of the underlying molecular causes, engineers can be creators rather than empiricists.

Applicants should preferably have training corresponding to a doctor's or master's degree in science or engineering, although special experience will be taken into consideration.

In addition to Professor von Hippel, ten other MIT professors covering the fields of physics, chemistry, and mechanical and electrical engineering will participate in the program. Also nine authorities on various phases of the program, from industry and other academic institutions, will present lectures.

Included in this industry group is K. N. Mathes, prominent member of ASTM Committee D-9 on Electrical Insulating Materials, whose subject will be ASTM Tests—Their Interpretation and Use. Following this lecture, which will occur on the first day of the program, there will be a discussion on test procedures and their justification and significance.

Other subjects to be considered are electrical discharges in gases, single crystals, dislocations and mechanical properties of materials, irradiation effects, ferroelectric and ferromagnetic materials and devices, nondestructive analysis of materials, and electric breakdown in liquids and solids.

EDITOR'S NOTE—Professor von Hippel's views on molecular engineering predicting a revolution in the approach to development of engineering materials are set forth in a controversial paper published in *Science* (Vol. 123, No. 3191), and *Technology Review* (MIT) (March, 1956). This paper is also available from MIT as Technical Report No. 101.

Building and Strain-Gage Courses.

Plastics in Building and Strain-Gage Techniques are two other of the Special Summer Programs which will be given at Massachusetts Institute of Technology this summer.

The plastics program, July 2–13, will study plastics and their growing use in buildings as exemplified in the design and detailing of a small residential structure.

The strain-gage program is divided into two parts—Techniques and Applications—July 16–20 and July 23–27. These programs will include a survey of both the theoretical aspects and practical considerations involved in the use of strain gages for various purposes with emphasis on application of techniques to industrial problems.

Details and application blanks can be obtained from the Summer Session Office, Room 7-103, MIT, Cambridge 39, Mass.

Determination of the Accuracy and Usefulness of the Carnauba Wax Benzene Solubility Test

TASK GROUP X[1] of Subcommittee II on Raw Materials of Committee D-21 on Wax Polishes and Related Materials was assigned the evaluation of the Benzene Solubility Test. This test, which was originally promulgated by the American Wax Importers and Refiners Assn., was subject to an interlaboratory test program especially in regard to its accuracy, reproducibility, and variations in per cent solubility due to temperature change.

Comments on this test are solicited and should be addressed to the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Sample

Several pounds of "Marc Jacob" brand crude Parnahyba wax were crushed and well mixed. About 3 lb of this was then ground in a high-speed blender until small enough to pass through a 20-mesh screen. This screened wax was again mixed and used as the Carnauba wax sample supplied to members of the Task Group.

Constant-Temperature Baths

Constant-temperature baths were constructed from enamel pots, 10 in. in diameter and 11 in. high, in an immersion heater (Fisher, 11-463-5; 300 watt) controlled by a thermoregulator (Fisher, 15-179). Each bath contained approximately 20 lb of water.

Standard sewing-machine motors, whose speed was controlled by rheostats, drove two small propellers in each bath. One propeller was located near the outer part of the vessel, serving to keep the water well stirred. The other propeller served to keep the powdered Carnauba wax and benzene well agitated in a 250-ml flat-bottom Pyrex extraction flask which was immersed to its neck in the water bath and held by clamps. The extraction flask neck was fairly well sealed against loss of benzene vapors by being placed close to the wooden crosspiece to which the stirrer bearings, motor, pulleys, and shafts are attached.

The heater controlled unit made it possible to operate in the range of 25 to 30 C when the room temperature was below that desired; either unit could be cooled by the careful addition of ice when room temperatures were above experimental working temperatures. Because of the weight of water used in each bath, the temperature control with either ice or electric heater was not difficult once the working temperature was reached. With the immersion heater, temperatures could be controlled to $\pm \frac{1}{4}$ deg; equally good results could be achieved with ice if the run was closely watched.

Procedure

Fifteen grams of the ground wax were weighed to ± 1 cg and placed in the extraction flask and 150 ml of benzene (80 to 82 deg purified) was added. The flask was then placed in the constant-temperature bath and extracted with constant stirring for 2 hr. It was then removed and the contents filtered through a 19-cm folded filter. 100 ml of the filtrate was then evaporated in a weighed Pyrex dish on a hot plate until the benzene was entirely evaporated; the residue and dish cooled, and weighed.

While it is evident that the amount of filtrate evaporated does not perfectly represent the solubility of 10 parts of Carnauba in 100 parts of benzene at the temperature of test, it was felt, nevertheless, that this method will yield a more truly representative value than would any attempt to filter off the benzene and then wash with more benzene. In the latter case there is also the possibility of error in that more wax may be dissolved by fresh benzene.

Test Results

The test results submitted by the three reporting members of the committee are given in Table I.

TABLE I.—TEST RESULTS FROM THREE LABORATORIES.

Temperature, deg Cent.	Solubility of Carnauba Wax in Benzene, per cent		
	Laboratory A[a]	Laboratory B[b]	Laboratory C[c]
24.5	5.3		4.41
	5.1		4.44
25.5	5.6		5.18
	5.5	5.35	5.26
26.5	6.9		
	6.6		5.82
27.5	7.5		
	7.1	7.13	6.68
28.5	8.1		
	8.1		7.61
29.5	8.8	8.93	
	8.7		

[a] Lab A—M. Argueso.
[b] Lab B—Stillwell & Gladding, Inc.
[c] Lab C—U. S. Testing Co.

Conclusions

1. The benzene-solubility test is very susceptible to temperature variations and must be run with adequate stirring and close temperature control. During hot weather especially, a constant-temperature bath is a necessity.

2. The solubility curve in the 25 to 30 C range approximates a straight line with a rise of approximately 60 per cent in solubility from 25 to 30 C.

3. Carefully run, the test will produce results accurate within at least $\frac{1}{4}$ to $\frac{1}{2}$ per cent when the work is done by one observer using the same apparatus. Between different but capable operators, the accuracy would appear to be between $\frac{1}{2}$ and 1 per cent. This accuracy seems to be dependent upon the closeness of control of the constant-temperature bath.

4. The method demands accurate thermometers, thorough heat control and adequate stirring.

5. Without close temperature control the test would appear to be valueless, since the results show a variation of approximately 4 per cent over 5 C.

6. While no opinion has been rendered by the committee members as to the over-all value of the benzene solubility test its worth has undoubtedly been reduced by the introduction of the chromatographic method of determining paraffinic type hydrocarbons in Carnauba. Its value is probably greatest in showing the presence of mixed adulterants whose individual solubilities will considerably raise the total solubility as shown.

Acknowledgment:

The chairman wishes to thank the cooperating members for the wholehearted efforts which they rendered.

[1] Task Group X of Subcommittee II consisted of the following members: H. W. Dippel, Stilwell & Gladding, Inc.; C. S. Treacy, M. Argueso & Co., Inc.; Barney J. Zmoda, U. S. Testing Co.; Charles J. Marsel, New York University; and John Marvinny, Frank B. Ross Co.

Determination of "Active" Sulfur Content of Sulfur-Bearing Cutting Fluids

Report of Subsection 1[1] of Section I, Technical Committee K, ASTM Committee D-2 on Petroleum Products and Lubricants

Prepared by O. L. Brandes

SUBSECTION 1 on Analytical Tests is concerned with the laboratory evaluation of cutting fluids from the standpoint of analytical procedures.

This report summarizes the results of the subsection on one procedure appearing in the literature, which deals with the determination of the so-called "active" sulfur content of cutting fluids. The method in question was published in Federal Specification VV-O-283.[2]

The subsection does not prefer this method over other published procedures.[3] In fact, the subsection is fully agreed that information relating to the laboratory and field performance of cutting fluids is insufficient to enable valid selection of an analytical procedure. The method in Federal Specification VV-O-283 was selected because it appears in specifications on cutting fluids, is relatively simple and convenient, and is one of the procedures in rather general use.

Test Procedure

As published in Federal Specification VV-O-283:

"Active sulfur: One hundred grams of the cutting oil to be tested is placed in a 250-ml. tall form, lipless beaker, and 20 g. of copper powder added. The mixture is heated rapidly to 300 F (vigorous agitation is used during the heating period), and held at that temperature for 1 hr. The treated cutting oil is filtered. The sulfur contents of the treated oil and of the original oil are determined by F. S. Method 520.2 (ASTM Method D 129). The difference between the sulfur content of the original oil and the sulfur content of the treated oil is reported as active sulfur content."

In addition to this procedure, the subsection also investigated briefly a slight modification involving copper powder reduced by heating in an atmosphere of hydrogen.

Test Fluids

Two sets of fluids were employed in this investigation, four in the first set and five in the second. These fluids were representative of those in general use. They covered a wide range of sulfur content and contained both natural and added sulfur. Further, the fluids were identical to those under investigation by other subsections of Section I (Laboratory Evaluation of Cutting Fluids), and by Section II (Plant Evaluation of Cutting Fluids) of Technical Committee K on Cutting Fluids. This was done to compare "active" sulfur contents of the fluids—as measured by this method (Federal Specification VV-O-283)—with the ratings of the same fluids in laboratory bench tests and in plant evaluation tests.

The fluids selected for test were characterized generally as follows:

Test Results

Nine laboratories participated in tests on the first series of test fluids (TCK-11 to TCK-14, inclusive); six of these laboratories determined "active" sulfur contents by the method published in Federal Specification VV-O-283 and by this same method modified to include reduction of the copper powder by heating in a hydrogen atmosphere prior to use. The results of these determinations are given in Table I.

Six of the cooperating laboratories determined "active" sulfur contents of the second series of test fluids (TCK-17 to TCK-21, inclusive). The results of these tests are given in Table II. Reduction of the copper powder by hydrogen was not investigated in this second series of tests since no advantage was evidenced for this modification in the preceding tests on the first series of test fluids.

Referring to the data in Tables I and II, the following points appear of chief interest:

1. Agreement between the participating laboratories for both total and "active" sulfur contents of the first

First Set

Test Fluid	Viscosity, at 100 F (38 C), Saybolt Universal sec	Total Sulfur, per cent by weight	Chlorine, per cent by weight	Fatty Matter, per cent by volume (approximate)
TCK-11	120	0.30	0.10	1.0
TCK-12		0.91		3.7
TCK-13	161	0.40	Nil	9.0
TCK-14	116	0.80		Nil

Second Set

TCK-17	A straight mineral oil of 125 to 150 sec Saybolt Universal viscosity at 100 F. Natural sulfur content, 0.5 per cent maximum.
TCK-18	A mineral oil-fatty oil blend, 125 to 150 sec Saybolt Universal viscosity at 100 F. Comprised of 90 per cent mineral oil and 10 per cent lard oil.
TCK-19	A moderately sulfurized mineral oil of 125 to 150 sec Saybolt Universal viscosity at 100 F. Added sulfur, 0.8 per cent.
TCK-20	A heavily sulfurized cutting oil of 125 to 150 sec Saybolt Universal viscosity at 100 F. Contained addition of 10 per cent of a sulfurized fat base; sulfur content of the sulfurized fat base was 10 per cent.
TCK-21	A heavy-duty cutting oil of 125 to 150 sec Saybolt Universal viscosity at 100 F. Added sulfur, 1.5 per cent; added chlorine, 1.0 per cent; and fatty matter, 10.0 per cent.

[1] Membership of Subsection 1 during the period of this work: O. L. Brandes, Gulf Research & Development Co., chairman of Subsection 1; R. W. Curtis, Carlisle Chemical Works; E. W. Drummond, International Harvester Co.; H. A. Erickson, D. A. Stuart Oil Co., Ltd.; N. J. Gothard, Sinclair Refining Co.; Gus Kaufman, The Texas Co.; E. M. Kipp, Aluminum Company of America; L. H. Sudholz, Socony Mobil Oil Co., Inc.; and J. E. Wilkey, The Cleveland Graphite Bronze Co.

[2] "Oil; Cutting, Sulfurized-Mineral," *Federal Specification VV-O-283* (July 5, 1945).

series of test fluids was generally satisfactory. These fluids ranged from negligible to less than 0.5 per cent active sulfur content as determined by the method of Federal Specification VV-O-283.

2. Reduction by hydrogen of the copper powder for the "active" sulfur test in Federal Specification VV-O-283 had no significant effect on the results. Agreement between the laboratories using the reduced copper powder was not good in the case of fluid TCK-13.

NOTE.—In general, the cooperating laboratories used a finely dispersed (for example, precipitated) copper powder in conducting these tests. With coarser and less uniform grades of copper powder than employed for the tests reported herein, results would not necessarily be the same. Reduction of the coarser copper powder with hydrogen prior to use might be advantageous.

3. For the second set of test fluids, the data available indicate general agreement between the laboratories with respect to level of "active" sulfur content as determined by the method of Federal Specification VV-O-283. However, the present data are inadequate to establish precise limits for repeatability and reproducibility of results.

Although the values obtained by Laboratory D using a Parr peroxide bomb were, for test fluid TCK-21, somewhat below the average values obtained by the other participants, no particular significance can be associated with this observation; similar irregularities did not occur in the values determined by Laboratory D for the remaining test fluids (TCK-17 through TCK-20, inclusive).

General Considerations

The subsection recognizes that "active" sulfur as measured by the method of Federal Specification VV-O-283, or by other similar procedures, is simply a measure of that portion of the sulfur content of a cutting fluid which will react with the metal or metal powder (copper powder in the case of Federal Specification VV-O-283) under the particular conditions of test employed. Obviously, the so-called "active" sulfur content measured in such fashion will vary with differences in the severity of test conditions imposed by the given procedure. For example, in a parallel series of tests on the same fluids referred to herein, certain of the participating laboratories substituted finely-divided iron powder for the copper powder

[a] Harry Levin and Ervin Stehr, "Determination of Free Sulfur in Lubricating Oil," *Industrial and Engineering Chemistry, Analytical Edition*, Vol. 14, p. 107 (Feb. 15, 1942).

TABLE I.—"ACTIVE" SULFUR CONTENT OF FIRST SERIES OF TEST FLUIDS AS MEASURED BY THE METHOD DESCRIBED IN FEDERAL SPECIFICATION VV-O-283.

Laboratory	Test Fluid	Total Sulfur (ASTM D 129),[a] per cent	"Active" Sulfur (Federal Specification VV-O-283), per cent	
			Copper Powder, 1 hr, 300 F	
			As Received[b]	Reduced[c]
A	TCK-11	0.35	0.13	0.12
B		0.36	0.13	0.13
C		0.34	0.12	0.13
D		...	...	0.12
E		0.35	0.12	...
F[d]		0.41	0.20[e]	...
G		0.35	0.106	...
H		0.40	0.14	0.17
I		0.34	0.10	0.11
Average:		0.36	0.12	0.13
Deviation maximum:		0.05	0.02	0.04
Deviation average:		0.02	0.01	0.01
A	TCK-12	0.90	0.05	0.03
B		0.88	0.04	0.02
C		0.90	0.03	0.04
D		...	...	(0.18)[e]
E		0.91	0.02	...
F[d]		0.90	0.05	...
G		0.87	0.015	...
H		0.92	nil	0.01
I		0.90	0.03	0.07
Average:		0.90	0.03	0.03
Deviation maximum:		0.03	0.02	0.04
Deviation average:		0.01	0.01	0.02
A	TCK-13	1.90	0.37	0.29
B		1.86	0.40	0.49
C		1.89	0.45	0.43
D		...	...	0.59
E		1.95	0.41	...
F[d]		1.95	0.38	...
G		1.83	0.36	...
H		1.90	0.42	0.35
I		1.87	0.27[e]	0.37
Average:		1.89	0.40	0.42
Deviation maximum:		0.06	0.05	0.17
Deviation average:		0.03	0.02	0.08
A	TCK-14	1.10	0.20	0.17
B		1.08	0.18	0.16
C		1.10	0.21	0.19
D		...	...	0.33[e]
E		1.12	0.21	...
F[d]		1.08	0.13	...
G		1.08	0.185	...
H		1.14	0.19	0.21
I		1.09	0.15	0.16
Average:		1.10	0.18	0.18
Deviation maximum:		0.04	0.05	0.03
Deviation average:		0.02	0.02	0.02

NOTE—Each of the individual values shown above for total and "active" sulfur contents represents averages of two or more determinations agreeing within the limits of reproducibility for sulfur content measured by ASTM Method: D 129–44.

[a] ASTM Standard Method of Test for Sulfur in Petroleum Products and Lubricants by Bomb Method (D 129) appears in its latest form in 1955 Book of ASTM Standards, Part 5, p. 81. The method lists the following limits for repeatability and reproducibility for total sulfur content:

Total Sulfur Content, per cent	Repeatability, Same Operator and Apparatus	Reproducibility, Different Operators and Apparatus
0.0 to 0.5	0.015	0.03
Over 0.5 to 1.0	0.02	0.04
Over 1.0 to 2.0	0.025	0.05

[b] The copper powder used included: (*a*) Analyzed-grade copper powder (J. T. Baker), (*b*) precipitated copper powder (J. T. Baker), and (*c*) copper metal, electrolytic dust (Eimer and Amend).

[c] Copper powder reduced by: (*a*) heating in a furnace in a hydrogen atmosphere; or by (*b*) spreading the copper powder along the length of a piece of Pyrex tubing tapered at one end to a small opening, and equipped at the hydrogen inlet end with a seal to prevent escape of hydrogen into the room. Hydrogen under slight pressure is admitted to the tube and exhausted from the exit side into the outside atmosphere. The tube is flushed thoroughly to remove air (oxygen). Low heat is applied gently by flame over a length of wire gauze wrapped about the tube. Only enough heat to effect slow reduction of the powder is applied. When reduction is complete, the heat source is removed, and the flow of hydrogen is continued until the powder has cooled to room temperature. A safety shield is used to protect the operator.

[d] Laboratory F used a Parr peroxide bomb rather than that specified by ASTM Method: D 129–44 (now D 129–52).

[e] Not included in averages shown.

TABLE II.—"ACTIVE" SULFUR CONTENT OF SECOND SERIES OF TEST FLUIDS AS MEASURED BY THE METHOD DESCRIBED IN FEDERAL SPECIFICATION VV-O-283.

Laboratory	"Active" Sulfur (Federal Specification VV-O-283), per cent				
	Test Fluid				
	TCK-17	TCK-18	TCK-19	TCK-20	TCK-21
A	0.06	0.07	0.81	0.83	1.63
B	−0.01	−0.01	0.78	0.89	1.46
	0.00	−0.01	0.79	0.88	1.56
	0.02	0.00	0.78	0.83	1.52
	...	...	...	...	1.60
	Average:		0.78	0.87	1.53
C	−0.03	0.00	0.87	0.99	1.49
	0.00	0.01	0.85	0.92	1.59
	Average:		0.86	0.95	1.54
D[a]	0.00	0.00	0.90	0.93	0.91
	...	...	0.96	0.83	0.98
	...	...	0.92	0.87	1.02
	...	...	...	...	0.95
	Average:		0.93	0.89	0.97
E	−0.04	0.03	0.72	0.83	1.46
	0.03	0.00	0.77	0.87	1.47
	...	...	...	0.85	...
	...	...	...	0.79	...
	Average:		0.74	0.83	1.46
	Average:		0.82	0.87	1.54[b]
	Deviation maximum:		0.11	0.08	0.09[b]
	Deviation average:		0.06	0.04	0.04[b]

[a] Laboratory D used a Parr peroxide bomb.
[b] Laboratory D values not included.

designated by Federal Specification VV-O-283. It was found that the "active" sulfur reacted more readily with the copper than with iron under the conditions of the test.

In yet another series of tests, the subsection determined the "active" sulfur contents of test fluids TCK-11 to TCK-14, inclusive, using the method of Levin and Stehr.[3] The "active" sulfur contents thus determined were also considerably lower than the "active" sulfur contents measured for the same fluids by the method of Federal Specification VV-O-283, as would be anticipated from the lower temperature of test involved in the Levin and Stehr method. It is of interest to note here that one of the participating laboratories found that the "active" sulfur contents of test fluids TCK-11 to TCK-14, inclusive, as determined by the method of Federal Specification VV-O-283, were essentially the same as those determined by a slight modification of the method of Levin and Stehr. This modification comprised substitution of Stoddard solvent for the acetone-benzene solution called for by the published Levin and Stehr procedure. This modification of the Levin and Stehr procedure provided a temperature (reflux) of 320 F as compared with the temperature of 300 F employed in the procedure of Federal Specification VV-O-283.

It is recognized that the temperatures used in the analytical procedures mentioned herein are far below those existing between the tool and workpiece in operations such as metal cutting. In so far as known, the extent to which "active" sulfur content as determined by such laboratory procedures will reflect sulfur activity and performance of cutting fluids in service applications has not been established conclusively. Further information along such lines is required as a basis for appraising the relative significance of analytical procedures now in use, or to be developed, for laboratory evaluation of cutting fluids.

Summary

Subsection 1 of Section I, Technical Committee K, conducted two series of cooperative tests comprising the determination of "active" sulfur contents of a total of nine representative sulfur-bearing cutting fluids using the method of Federal Specification VV-O-283. The results of these tests, reported herein for purposes of information only, indicated:

1. Fair to good agreement of results among the participating laboratories.
2. No apparent advantages accompanying reduction of the copper powder by heating in an atmosphere of hydrogen prior to use in this test procedure (Federal Specification VV-O-283).

The subsection emphasizes that further information as to the correlation of "active" sulfur contents of cutting fluids—as determined by laboratory procedures such as that of Federal Specification VV-O-283—with behavior of the fluids in reliable performance tests, and finally in service, is needed before a valid appraisal of the significance of such laboratory analytical procedures can be made.

Survey on Stress Corrosion Cracking Underway

In recognition of the growing interest in the problem of stress-corrosion cracking of austenitic stainless steel equipment, Subcommittee IV on Methods of Corrosion Testing of ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys has joined hands with the National Association of Corrosion Engineers Technical Unit Committee T-5E on Stress Corrosion Cracking of Austenitic Stainless Steel in a survey of this subject. A questionnaire is being sent out to the members of both committees, the purpose of which is to determine the extent of this problem, the kinds of service and the alloys most often involved, and the steps being taken to combat cracking. In addition, information is being sought on the extent and character of research activity in this field.

A survey of this kind should be particularly helpful in indicating how future research effort can be most fruitfully directed and in what way the two committees can most effectively contribute to this effort.

Anyone not a member of either committee who is interested in participating in this project can secure copies of the questionnaire by writing to F. K. Bloom, ASTM Subcommittee IV, A-10, Research Laboratories, Armco Steel Corp., 3400 E. Chase St., Baltimore 13, Md., or to L. M. Rogers, NACE Unit Committee T-5E, Carbide and Carbon Chemicals Co., P. O. Box 471, Texas City, Tex.

Electron Microscope Course

Cornell University's Summer Laboratory Course in Techniques and Applications of the Electron Microscope will be given again this summer from June 11 to June 23, 1956.

The course is designed to give members an intensive survey of basic theory and interpretation of results. Registration is limited so that ample facilities are available for each one to pursue laboratory work in his special field at an introductory or advanced level. Further inquiries should be addressed to Prof. B. M. Siegel, Department of Engineering Physics, Rockefeller Hall, Cornell University, Ithaca, N. Y.

Government and Industry Standardization . . .

ARE OUR OBJECTIVES THE SAME?

By Norman L. Mochel[1]

AT THE outset let me state unequivocally that ASTM strongly supports closer contact between industry and all levels of Government in the development of all standards. By ASTM I mean the thousands of members who *are* the Society—2600 leading companies, about 300 influential technical or scientific societies, and over 5000 individuals, material experts all. We believe this so strongly that we are pledged to work unceasingly for continued coordination of industry and Government standards. And we are not so cocksure of our work that we think industry is *always* right.

ASTM's work in standards is based in one sense on adjusting the divergent views in many instances, of the maker and the buyer. We have thrived on adjustment; and so has American industry; and so have our city, state, and Federal governments. They have improved their operations and helped to make our standard of living the envy of all the world. Let us admit *that* humbly and with the realization that it carries proportionate responsibility for our fellow men everywhere.

One Example

There are many notable examples where compromise and adjustment between the producer and the user have resulted in acceptable standards. Almost every ASTM document is in this category. Recently there was a rather striking example of compromise, or perhaps we might say coordination, of industry's thinking on a standard, namely, on the widely used Federal methods of testing metals. This document, QQ 151, is being extensively revised, and for many months various branches of Government and an engineering firm have been developing descriptions of the latest methods of testing metals. Considering the tremendous volume of metals purchased, one can realize the significance of this revised and expanded document. After many months of work, it was felt desirable to seek the reaction of leading technologists in major industries concerned. This was done by asking the ASTM Army Ordnance Advisory Committee to sponsor an all-day meeting at which selected industrial leaders, after studying the respective portions of the document, would give their evaluations. At a session in Washington, one of the most intensive meetings that I believe some of our people had attended, many proposals were reviewed and recorded. This was an inspiring meeting, a truly democratic way of providing the leading technical authorities in Government with the views of our industrial technologists.

MR. MOCHEL'S PAPER was presented at a session entitled "Relationship of Industry Standards and Specifications to Those of Government" in the Sixth Annual Conference on Standards sponsored by the American Standards Association and the National Bureau of Standards in Washington, D. C., October 26, 1955. Copies of the Proceedings of this Conference on Government-Industry Cooperation in Standardization can be obtained from the ASA, 70 E. 45th St., New York City, for $3.

I am advised that, of the large number of suggestions, some major, some minor, about 85 per cent were adopted. Thus real progress was made from the standpoint of coordinating our industrial procedures with those advocated by the various branches of the Government interested in testing metals. Please do not think that the large number of suggestions in any way reflected on the quality of the job that had been done. Our people were high in their praise of the excellence of the document given them for review. There were many new areas to cover involving a number of technical difficulties. The point is that this document when issued will be modern and up to date and, on the most vital matters, in accord with the latest industrial practices.

Objectives

We certainly should be able to coordinate almost completely our methods of testing materials and products, and much progress has and is being made in this area. Now why do we feel so strongly about coordinating industry and Government standards? Perhaps if we think a bit about the ultimate objectives of those in industry and Government who must use standards, particularly those responsible for purchasing policies and execution, we might find a basic similarity.

To me it seems that the objectives are the same. They are: to procure the proper product or material, satisfactory for the use indicated, on terms that will insure continued satisfactory relations between the two parties. No buyer wants to live with too high prices; no seller wants to go out of business. The purchaser wants the *best* he can obtain for his purpose; the best, however, must be consistent with judgment on cost economy.

We do not assume that all Government and all so-called industry specifications can be fully coordinated, but a great many can and should be. In the field of large steel forgings, for instance, it could be assumed that gun forgings may need special qualities (resistance to shock, for example) that would not be so essential in giant rotor forgings for a 200,000-kw turbine generator. Basically, however, there are many things considered essential in the one that are equally essential in the other, and studies now under way in the Society structure emphasize the point that some of the properties that might be considered peculiar to the gun forging are quite important to the rotor forging as well. Methods of evaluation may be quite close.

Our metallurgists are under terrific pressure to use the best materials in our forgings, as our designers come up with giant machines requiring metals to operate at previously unthought of pressures and temperatures. But a bolt for a bridge erected by the Federal Goverment could be the same as that for a state highway bridge and for a steel or chemical plant structure.

We feel strongly that many more economies in Government can come

[1] Manager, Metallurgical Engineering, Westinghouse Electric Corp., Philadelphia, and ASTM Past-President.

from continuing the policy of using so-called industry standards in those cases where the products would be satisfactory for the purpose intended. Industry will benefit from concentration on standardized quality and tests; and costs should be lower. An interesting case arose when one of our Government groups preparing standards for land-base operations was not satisfied to use industry standards which for many years had proved their service in marine installations. Usually we consider that shipboard service is much more rigorous than stationary. This situation, I might say, has been rectified and I am certain that our Government costs have been materially reduced.

Savings Through Coordination

Industry does not want to operate on the basis of specials and extras. One of our leading military men has stated his conviction that we cannot justify in peacetime unnecessary and special requirements because, in the event of war, production must be at its highest and industry can produce best on standardized requirements.

We have more than 7000 men working on our innumerable technical committees which are concerned with standards for materials of all kinds. We feel the ultimate aim of our standardization work will not be reached and the skills of the men utilized adequately simply by issuing more and more standards, specifications, and tests. The ultimate objective, obviously, is to coordinate these standards by adjustment and understanding so that there will be a very minimum number on the particular subject.

In this coordination to which we are dedicated, we must continue to provide full opportunity for participation by all interested. The Government, through the General Services Administration, the Department of Defense, and the numerous other branches of the Federal Government must be amply represented as well as our state and city governments. We now have many competent men from these branches of government serving on our committees. This is mutually advantageous. Our committees learn of government's material problems at first hand. The government's materials experts learn of some of our production problems—and, from the other consumers on the committee, may obtain helpful information on improving applications.

Industry's Obligations

We have an obligation, and by this I mean all *associations and societies*, such as ASTM, to attempt to provide in our standards those requirements which will also meet, insofar as possible, Government needs. Obviously it is easier to talk about these things than to implement them. We hope with continuing pressure to assist in better activation. We pledge our forces to this end.

ASTM is a composite technical group composed of the consumer (including the Government), the producer, and the general interests, working together. It should be a good meeting ground for coordination. Industry, our city, state, and Federal governments, and the innumerable other groups concerned, working in our committees through their technical men, have, we hope, done much to stimulate the development and use of needed standards. Much more can be done in coordinating them.

We are impressed and gratified at the coordinating efforts now under way in the Department of Defense and the General Services Administration. We say well done to all concerned! And we'll continue to help all we can.

Proposed Spec Can Improve Capacitor Reliability

FORGING a new link in the chain of materials quality contributing to paper-capacitor reliability, ASTM will publish with the preprinted 1955 Annual Report of Committee D-9 on Electrical Insulating Materials, a proposed specification covering electrical insulating paper, sulfate (kraft) tissue for capacitor dielectric. This specification is being published as information, and comments are invited.

Although other materials such as plastic film and even thin flexible films of glass are increasingly used as the dielectric for a similar type of capacitor, the paper dielectric is still the large volume dielectric material used.

Such capacitors are important elements in numerous electronic circuits serving both as filters to provide smooth d-c from rectified a-c power supply units where electrolytic capacitors are unsuitable, and for bypassing and high-impedance coupling applications in electron-tube and transistor circuits. To insure adequate life expectancy capacitors should have high resistance to the passage of dc. In order to provide this property it is necessary to use a tissue having a very low concentration of ionic impurities. The proposed specification sets maximum limits on the conductivity of an aqueous extract, thus providing for a high degree of purity. Even with very pure tissue, it is necessary that the moisture content in the completed capacitor unit be of negligible proportions and that the impregnation and sealing against entry of moisture be adequate.

Other important characteristics of capacitor paper are uniformity of thickness, and a minimum number of conducting paths per unit of area. While two or more layers of paper are used to separate the metallic electrodes of the capacitor, there is always some slight possibility that two conducting paths may match up, thus causing a weak spot where the unit can break down prematurely.

H. A. Anderson, chairman of the subcommittee which developed this specification, described the standards of quality needed for capacitor tissue at the 1956 Electronic Components Symposium, held May 1–3, in Washington, D. C., under the cosponsorship of the AIEE, RETMA, IRE, and WCEMA in cooperation with several government departments. Mr. Anderson pointed out that experience indicates that capacitor performance in d-c service correlates with the initial leakage current and the number of dielectric failures for example, in 48 hr at 130 C, with an applied potential of 600 v per mil of dielectric thickness. Chemical and microscopic analyses of capacitor tissue appear to be an unsatisfactory means for differentiating between lots of kraft capacitor tissue showing either good or poor performance in predominantly d-c service applications. Some kind of performance test using a standardized capacitor test unit appears to be necessary.

This specification, which can contribute to improved capacitor reliability, can also contribute indirectly toward better reliability of electronic equipment generally. This improvement will apply to the large industry applications such as telephone and other communications services, instrumentation and electronic control apparatus, as well as home electronic equipment such as television and radio receivers, phonographs and tape recorders.

Electroplaters Meet June 18–21

FORTY papers embracing electroplating, metal finishing, and related fields will be presented at the 43rd annual convention of the American Electroplaters' Society at the Hotel Statler in Washington, D. C., June 18–21, 1956.

THE McKINNEY REPORT—

Blueprint for a Peaceful Atom

THE COAL and oil industries have little to fear from nuclear power developments. Though atomic power will assume an increasing role in the next few decades, the nation's power needs will demand more from conventional fuels as well as from the atom. Manpower required for a stepped-up atomic program will demand a higher level of skilled labor and an increased output of scientists and engineers capable of contributing to peaceful atomic uses. The AEC should make freely available all nonweapon atomic information to facilitate industry's participation in atomic developments. The Government should pursue a vigorous policy to maintain this nation's leadership by continuing to support research and encouraging a high level of industry participation in peaceful atomic developments.

These and other observations are included in the 904-page report[1] of the nine-man Panel headed by Robert McKinney, prepared at the request of the Joint Committee on Atomic Energy. The Panel's recommendations blueprint the peaceful atom's future—in power, in health and medicine, in agriculture, in food preservation, in transportation, and in its impact on the economy.

Recognizing that many factors can influence the future growth of atomic power, the McKinney Panel has placed an upper and a lower range on its predictions for U. S. atomic electric generating capability to 1980. These are summarized in the following table:

UNITED STATES ATOMIC ELECTRIC-GENERATING CAPABILITY.

(In millions of kilowatts)

	Annual Additions		Cumulative Installed Capability	
	Lower range	Upper range	Lower range	Upper range
1960	...	...	Less than 1	Less than 1
1965	...	...	Less than 3	Less than 4
1970	1	3	5	9
1975	5	11	20	45
1980	8	23	52	135

To place these figures in proper perspective, the predicted lower and upper range for total generating capability in 1980 is 360 and 600 million kilowatts. The present total U. S. power generating capability is about 120 million kilowatts from all sources.

Thermonuclear Power

While the Panel recognized that the development of controlled thermonuclear power as contrasted with power derived from atomic fission is truly a frontier research project, the gains from such developments could be great indeed. Thermonuclear power units give promise of being extremely safe, and the possibility of a serious accident from failure of components or arbitrary mistakes by the operator is virtually negligible. Upon the achievement of the goal of controlled thermonuclear reactions, the availability of intense neutron fluxes could make possible the production of fissionable materials through irradiation of uranium and thorium. This would greatly increase the availability of fissionable materials to the economy. With the present state of knowledge, the Panel was unable to make any prediction regarding the future developments of controlled thermonuclear power, but it strongly recommended that the Commission permit the maximum interplay of scientific and engineering ideas within the limitations of national security to foster these developments.

The Panel pointed out in its report that atomic ship propulsion can become economically competitive and recommended that the AEC, the Maritime Administration, and the shipping and shipbuilding industries work out a program for exploring the economic feasibility of atomic powered ships. Atomic propulsion for locomotives was also seen as a possible future application.

Among the general industrial uses for atomic energy, isotopes and radiation, the Panel pointed out the already tremendous savings in industry derived from the use of radioisotopes, particularly in measurements and process control. Process heat is another promising application of atomic energy, as is the use of radiation for material processing.

While not minimizing the possible damage which could occur from accidents with nuclear reactors, the Panel expressed the conviction that efforts should best be directed toward the accumulation of information about potential hazards so that the insurance industry could develop ways of meeting atomic insurance problems, rather than prematurely debating the necessity for Government relief of the present private insurance problem.

The Panel points out that before this growth in atomic power can be realized much time and effort and new technological accomplishments in chemistry, metallurgy, physics and engineering will be required. The present program of experimental power reactors will provide a background of operating experience and costs upon which more realistic estimates for future development can be made.

ASTM's Key Role

The key role which will be played by ASTM is seen when it is observed that nuclear power must compete economically with conventional power sources before there can be widespread use. Efficiency of nuclear reactors depends in large measure on the suitability of engineering materials used in their construction. Determining the properties of materials exposed to nuclear environments, particularly at high temperatures, will be problems for ASTM in the immediate future. That the Society has recognized its responsibilities in this area is evidenced by the establishment recently by the Board of Directors of a special Administrative Committee on Atomic Energy to guide the Society's nuclear activities.

No doubt the efforts of ASTM in developing information on materials to keep its standards for materials used in reactors abreast of developments, and in furthering the use of isotopes in materials testing, will contribute in large measure to the use of this important resource.

[1] *Peaceful Uses of Atomic Energy, Volume 1.* Report of the Panel on the Impact of the Peaceful Uses of Atomic Energy to the Joint Committee on Atomic Energy. 155 pp. (1956). Catalog No. Y 4.At 7/2:At 7/13/v., 1, Govt. Printing Office, 45¢.

Peaceful Uses of Atomic Energy, Volume 2. Background material for Vol. I. 749 pp. (1956). Catalog No. Y 4.At 7/2:At 7/13/v., 2, $2.

Random Samples...

FROM THE CURRENT MATERIALS NEWS

From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream, or address Random Samples, ASTM, 1916 Race St., Philadelphia 3, Pa.

Barnacle Bell

AN UNDERWATER telephone cable will soon cross the Atlantic Ocean. Previous cables, dating back to almost a hundred years ago, have carried only telegraph signals; transatlantic telephony has been entirely by radio. The number of available radio circuits is limited, however, and magnetic storms, associated with sunspot activity, impair transmission, especially of radio signals.

The key to long-distance telephoning by cable is the use of repeaters—electronic amplifiers that are placed at regular intervals in the cable, and are powered with terminal equipment. They increase the intensity of weak signals to useful levels before sending them along. Service maintenance of repeaters on overland cables presents no problems, but the transatlantic cable had to await development of electron tubes and associated equipment that would function for long periods of time and under extreme pressures.

As early as 1919, Bell System engineers established a research group for underwater cable technology; in 1920, long-range plans were made for a cable across the North Atlantic, but various factors caused the project to be set aside. Then in 1927, radiotelephone service crossed the Atlantic. By 1950, a submarine cable incorporating long-life components was laid from Key West to Havana; performance tests on this cable and in the laboratory showed that special electron tubes could be expected to last for twenty years on the ocean floor. The cable was so successful that the Long Lines Department of American Telephone and Telegraph Co., the British Post Office—which furnishes telephone service in the United Kingdom—and the Canadian Overseas Telecommunications Corp. decided to lay a submarine cable from Newfoundland to Scotland; the international project was formally initiated on December 1, 1953. The new cable will actually be two separate one-way cables, laid 20 miles apart on the ocean floor between Oban, Scotland, and Clarenville, Newfoundland, a distance of 1950 nautical miles. Sections of both land and submarine cable will connect the western terminus to Sydney Mines, Nova Scotia, and a new microwave relay system will extend 575 miles from there to Portland, Me., to link with the U. S. telephone network. The cable system will have a capacity of 36 telephone channels, and each of the twin, deep-sea cables will employ 52 one-way repeaters.

The deep-sea cable is about $1\frac{1}{4}$ in. in diameter, and is protected by outer wrappings of jute and galvanized-steel armor wire. The inner portion includes a central copper conductor insulated with polyethylene, an overlay of copper tapes, and wrappings for mechanical strength. Portions of the cable to be laid near the shore are armored more heavily to offset possible damage from ships' anchors, icebergs, high waves, or fishing gear; here the cable diameter reaches 2 to 3 in. Manufacture of the cable is itself an international project, part of the job being done by Simplex Wire and Cable Co. of Cambridge, Mass., and part by Submarine Cables, Ltd., of London, England, the oldest submarine cable manufacturing company in the world. The portion for the shallow Cabot Strait between Newfoundland and Nova Scotia was designed by the British Post Office, because of their greater experience with repeatered shallow-water cables. Electronic repeaters for the Clarenville-Oban section, built by Western Electric Co., are flown to England for insertion into the portion of the deep sea cable being made there; repeaters for the Clarenville-Sydney Mines section are being manufactured by Standard Telephones and Cables, Ltd.

In addition to many other components each repeater in the Atlantic cable includes three of the long-life electron tubes, which receive operating power from regulated current sent over the cable itself. The tubes operate in three stages; in the process, each repeater amplifies the weakened incoming signal one million times. The power system has been specially designed to feed the correct amount of current to the repeaters under the sea even under abnormal conditions, such as magnetic storms, that can reduce currents in the cable as the earth's magnetic field varies.

In order to pass over the drum of the cable-laying ship, the repeater has a flexible housing; to obtain this flexibility, the components of each repeater are mounted in a series of 17 linked sections. Each section is steel jacketed to withstand sea-bottom pressures of more than 6800 psi. The repeater, just a bulge in the cable, is about 8 ft long and 3 in. in diameter; tapering ends make the complete unit about 80 ft long. The British repeaters have a torpedo-like case, 9 ft long and $10\frac{1}{2}$ in. in diameter.

To lay the transatlantic telephone cable, the largest cable ship afloat, HMTS *Monarch*, was refitted with new cable-laying machinery; the initial stage of the job was carried out during the summer of 1955, when an entire length of cable between Clarenville and Oban—the one that will carry speech from west to east—was laid. Completion of the project is scheduled for later 1956.

—*Industrial Bulletin*,
Arthur D. Little, Inc.,
January, 1956

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New Tool for Steel Construction

THE STEEL construction industry will be interested in the development of an air-operated nut-running tool which impacts the nut to a desired preset torque for precision tightness, then automatically shuts itself off.

It is believed that the new tool will speed the bolting of steel construction and make it less costly. In place of a four-man riveting team, the tool requires only a two-man bolting team—one to run the tool and another to hold the bolt. Further, it takes weeks to develop maximum efficiency in a riveting team. No training is necessary to run down

bolts or nuts with the Torque Control Impactool, and testing for proper tension is eliminated. While Impactools have been used on bolted steel construction under certain controlled conditions, the new torsion bar torque control brings new accuracy to the tightening of bolts to specified torques.

The action of the mechanism can be likened to that of a pogo stick, which bounces evenly on soft ground, but suddenly rebounds higher when it strikes a hard surface. While the nut is being run to required torque, the new Impactool operates at normal power and speed, but when required torque is reached and nut running resistance is equal to the stress preset in the torsion bar, the impact mechanism rebounds instantly and trips a rubber-faced shutoff valve.

For further information, write to Ingersoll-Rand Co., Air Tool Division, 11 Broadway, New York 4, N. Y.

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Aluminum-Coated Steel Wire

HOT-DIPPED aluminum-clad steel wire is now being produced in a new line recently installed at the American Works of U. S. Steel's American Steel and Wire Division in Cleveland, Ohio. This 16-strand, full-scale production unit is the first commercial installation of the American Steel and Wire Division for manufacturing the new product. The new facilities are capable of producing aluminum-clad wire in sizes ranging from 6 to 18 gage in either 16- or 22-in. diameter coils.

The installation uses improved techniques to produce the necessary degree of surface cleanliness of the steel to be coated, to assure complete aluminum coverage, and to attain the necessary degree of ductility of the coating. Incorporated in the coating line is a furnace capable of withstanding the highly deteriorating effect of molten aluminum, thereby preventing contamination of the coating bath.

The aluminum coatings produced by the new line at American Steel and Wire are highly ductile as measured by well-known standard procedures of testing. Exceptional smoothness and luster are characteristics of these coatings. Higher wire tensile strengths or extremely lustrous finishes can be readily attained by cold-drawing after coating.

Aluminum-coated steel wires are expected to become an important supplement to standard galvanized wires for many manufactured products, as well as for merchant products. It is ideal for such products as lampshade frames, decorative grills, garment hangers, box binding, and pole-line hardware. It is also an excellent welding wire for some automatic processes.

Aluminum is far more resistant to most types of atmospheric corrosion than, for instance, zinc which to date has been the most commonly used coating material for steel. In addition, aluminum has been found to be quite resistant to the effects of elevated temperatures. It has been proved that aluminum-clad steel, when exposed to temperatures normally oxidizing to steel, will be converted to an alloy which is resistant to scaling at temperatures exceeding 1200 F.

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Strip or Tube?

A NEW MILL product in the form of a single strip, or sheet, of *solid* copper, brass, or aluminum in which tubes are inflated to desired running lengths in a variety of shapes or sizes was announced by Revere Copper and Brass, Inc.

Designated as Tube-In-Strip by Revere, the new product is said to have almost limitless and immediate applications in the heat-exchange field, including refrigeration and air conditioning, chemical, food and petroleum processing, automobile radiators, water heaters and coolers, gas heaters, radiant panel heating, and electronics, among others.

Coils and sheets of Tube-In-Strip are not discernibly different from the standard strip and roll products normally produced in the rolling mill. However this new material has incorporated within it expandable portions which can be inflated by the user into continuous running lengths of tube of whatever size and spacing or combinations of sizes and spacings that might have originally been designated. Except for the expandable portions, the metal is a solid strip derived from a suitably tested casting and the product *does not* consist of two pieces of metal brazed, welded, and rolled together. The metal can be stamped or drawn into desired shapes prior to the expansion of the channels. The expanded channels can be made circular in section, or during the expansion operation the metal can be forced into dies for the purpose of producing other than circular sections. It is also possible to inflate channels on one side of the strip or sheet only, leaving the other surface flat. Manufacturing procedures have been developed for copper and brass, the copper-base alloys in general, aluminum and aluminum alloys, zinc, and other ferrous and non-ferrous metals.

Tube-In-Strip can be furnished exactly as other sheet-metal mill products, in long coils or in cut flat sheets in widths up to 16 in. at present and wider later, the determining factor being the size of the casting billet from which the product is rolled to its desired width or gage. Tube spacing can be generally as close as $\frac{1}{4}$ in. and even closer in some instances, and as widely apart as the width of the metal permits. Inside diameters of the tubes can vary from approximately $\frac{3}{16}$ to $\frac{5}{8}$ in., inclusive, when unexpanded. Tube-wall gage can vary from 0.0025 in. to whatever the inflation equipment permits. A feature of the new product is the fact that tube diameters can be varied within a single piece of metal—made all alike if desired, or with each adjacent tube of different size, or with one side flattened, these variations affording unlimited design opportunities. It was planned to ship Tube-In-Strip to the consumer uninflated, thus making possible substantial shipping economies because it will be handled just as easily as sheet metals products when shipped in coils or in sheets. This is possible because inflation techniques are flexible and generally simple. For example, for thin-wall tube air pressure may be entirely adequate while for heavy walls hydraulic means of inflation may be better.

Stamping, forming, bending, and drawing operations can be performed before inflation, or the new product can be inflated before bending, perforation, and similar operations and then further processed by common pipe and tube bending techniques. Tube-In-Strip can be joined by means of normal commercial techniques. Manifolds, for either series or parallel flow, are easily produced either before or after inflation, and return bends can be brazed, soldered, or welded readily.

Prices for the new product call for a nominal mark-up over the price of sheet, roll, or strip of corresponding width, gage, and length in copper and its alloys and aluminum, as called for on the full catalog trade price list. At these prices, it is claimed that the new product offers opportunities for major economies because the user saves first in cost by buying tube and strip together, already fabricated to his design, rather than separately and, secondly, because new and improved designs are made possible. In that regard, it was pointed out that the web between the tubes conducts heat faster, and the vastly increased structural strength made by the inflated channels mean that lighter gage metals can be used with resulting savings in weight.

The Bookshelf

Transistors and Other Crystal Valves

T. R. Scott, MacDonald & Evans, Ltd., London (Essential Books, Inc., Fairlawn, N. J.); 258 pp.; $7.20.

DEVELOPMENTS in the field of semiconductors research and technology are moving at such a rapid tempo that extensive effort is required even for those active in this field to keep abreast of the pace of events. A particularly formidable problem is therefore presented to those scientists and engineers who are essentially newcomers in this specialized area. It is this latter group who will be especially grateful for the excellent contribution of Mr. Scott. Yet, this carefully integrated presentation, despite its relatively small size, has such a remarkably broad and thorough coverage that it is interesting and informative reading also for the more mature members of the profession.

A major factor which contributes in making a comprehensive and easily readable exposition is a broadness in scope, with careful attention to necessary physics and chemistry of materials, leading then to barrier and surface effects, and then to performance of specific devices. Finally, the inclusion of the two appendices on band structure and on testing techniques is very commendable, although unfortunately the former does suffer from a lack of preciseness. Most valuable is the unusually large and well-referenced bibliography, which includes results of considerable British as well as some German research not previously published.

As the author points out in his preface, "it was necessary to find a central theme round which could be built an array of facts which were not too much enveloped, from the engineers point of view, in a fog of physical and chemical theory . . . the theme finally selected was the part played by crystal imperfections in determining the characteristics of valves of all types. The control of these imperfections enables such devices to be developed, designed, and made with a wide range of characteristics which are nevertheless stable and reproducible." Hence, the short introduction is followed by a chapter on crystal imperfections. Here the author adopts the viewpoint advanced by Seitz and others of including phonons and therefore intrinsic electrons and holes. However, the distinction between perfect and intrinsic crystals is delayed for several paragraphs, so that the sentence on page 14: "The positive current carriers are created by crystal imperfections"; may at first reading lead one erroneously to exclude the electrons as arising from such a source. Unfortunately, there are a number of these ambiguities as well as typographical errors which need correction.

After discussing intrinsic material and describing the characteristics of its electrical conductivity, the author continues with the basic principles of doping and what this operation does to the electrical properties. Subsequent sections then deal with lattice defects and surface effects, and with carrier injection and diffusion processes.

Device operation is approached through a presentation of *p-n* junction theory. The discussion in this chapter includes rather extensive data on commercial germanium junction diodes, power rectifiers, photocells, grown junction transistors, and junction tetrodes of both American and British manufacturers.

The next chapter considers the pertinent aspects of point-contact devices, including some recent work on electroforming. Again, the listings of data on commercial models will be of interest to design engineers.

The subsequent chapters, also of great value to the applications engineer, cover rather thoroughly a number of practical aspects which make it obvious that Mr. Scott is very familiar with these phases of the semiconductor field. Again, liberal use is made of characteristics of actual designs. The chapters are entitled Operating Temperatures—Output—Life, Applications—Circuitry—Testing, and Special HF Transistors.

This reviewer was pleased to see the chapter on Choice of Semiconductors, which gives an adequate discussion of many of the compound semiconducting materials and the importance of research in this area. It is too bad, however, that more details are not available in the Elliott and Wolfson figure-of-merit determinations, since many differences of opinion are sure to exist regarding their results. The final chapter, which should rate as excellent, is appropriately titled Conclusions—The Future.

In summarizing, the author is at his best when he is dealing with the broad aspects of semiconductor technology or when he is concerned with details of device development or application engineering. The sections dealing with chemistry and physics, although an important and necessary inclusion, are written in a somewhat less precise manner. In particular, the appendix on band structure could use some revision; that on treatments of the Hall coefficient may be slightly confusing. Also, a number of the references quoted in this section seem to be rather obsolete, in contrast to those in the engineering sections. We must remember, however, that as pointed out in the jacket, the "book is written with the object of giving engineers who may have to use transistors . . . a clear picture of their development at the present time." This has been done successfully and, taken as a whole, it is this reviewer's opinion that Mr. Scott has made a good contribution to the literature of semiconductor technology.

A. C. BEER

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Steels for the User

R. T. Rolfe, Philosophical Library, New York, N. Y.; 391 pp.; $10.

WE HAVE here a refreshingly interesting book in that it deals, to all intents and purposes, solely with the carbon steels. The fundamentals are all here, with a wholly understandable progression from pure definitions of the mechanical properties in steels through all the ramifications of the application of the normal commercial product. In the "mechanical quality" portion of the text, the ruling section concept is defined and the effect of composition on mechanical properties is set forth. The cold-drawn and free-cutting steels are examined with certain case history usage delineated.

The theoretical considerations involved in the heat treatment of steel have a place, with the low carbon and the high carbon steels being treated as separate entities. The various case hardening methods all have received attention.

Expanding the concept of the use of steels, we find the elevated temperature area discussed at some length. There is available also a comprehensive treatment of fatigue testing as such.

The problems normally associated with the welding of steels receive due consideration.

The closing section of the book is devoted to a worthwhile summation of the principles normally associated with the selection of a steel in relation to the intended function.

A. W. MACLAREN

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OTS Reports

Office of Technical Services, U. S. Department of Commerce, Washington 25; 10 cents each

ALL applicable research reports in the OTS collection of over 250,000 documents are abstracted in the catalogs: CTR-319 **Cermets,** CTR-310 **The Transistor** (revised), and CTR-244 **Magnetic Amplifiers.** Technical reports available from OTS are primarily the results of research done by the Government or by private laboratories with Government sponsorship, but also include German technical papers captured by the Allies in World War II.

A Philosophy on Loading Tests*

By D. B. Dorey and W. R. Schriever

A review of Building Codes indicates a lack of uniformity in loading test specifications. A new approach to the formulation of test loadings and criteria is desirable in the light of technological advance.

A LOADING test provides a means of assessing the structural performance of a building or one of its components. A loading test is desirable, for instance, when there is doubt about the structural adequacy of a construction or when a structure cannot readily or accurately be subjected to engineering analysis. In conducting and evaluating a loading test many questions arise: What should the magnitude of the test load be? Is it adequate to state the test load simply as a multiple of the design live load? What criteria should be used to judge the success or failure of the structure in passing the test? Should it be a certain maximum deflection, a minimum recovery of deflection after loading, or both, or should it be merely the ability of the structure to sustain the test load for a certain time without showing signs of damage? What should the duration of the test load application be? What other details of the loading procedure should be specified?

Most building codes contain specifications on loading tests and describe to varying degrees the test procedure, but there exists a lack of agreement in the test requirements.

The inadequacy of existing loading test specifications has caused increasing concern in the field of civil and structural engineering, both in practice and in research work. The authors believe that these specifications are not in keeping with the present state of knowledge.

A number of existing loading test specifications found in use in various parts of the world were reviewed by the authors. The chief requirements of these have been summarized in Table I.

Review of Building Code Loading Test Specifications

An examination of Table I will show that these specifications differ in principle, detail, and procedure. Some specifications for instance deal with concrete structures only, and use merely the recovery of deflection after the test as a criterion for acceptance. Only two of the specifications listed state a minimum age for the concrete before the test is started.

Many clauses differentiate between a "strength test" and a "performance test" (see third column of Table I) although the use of these terms is not always the same. In the tests referred to as "strength tests," *all* the criteria (no signs of failure, deflection, and recovery) have been used by one code or another. Generally, the term "performance test" is applied to a check on deflection, under a load varying from $1 \times$ live load to $1\frac{1}{2} \times$ live load $+ \frac{1}{2} \times$ dead load. Some codes refer to a "workmanship test," under a load of $2 \times$ live load, with requirements in terms of no signs of failure coupled with a maximum deflection and a minimum recovery in case the deflection (as calculated from accepted engineering formulas) is exceeded. The British Standard Code of Practice is the only code making a clear distinction between a stiffness and strength test, using deflection *and* recovery as criteria in the first case, and recovery in the second. It should also be noted that not all tests apply to all materials.

From their review of loading test specifications, the authors conclude that a fundamental and thorough review of all the factors entering into loading tests on structures is necessary before any significant improvement in the specifications can be achieved.

Purpose and Scope of Loading Tests

There are many factors to consider in the formulation of a loading test specification. It is, therefore, useful and necessary at this point to outline the types of tests, their purpose and scope, and their relation to design principles.

There are three types of loading tests to consider in the formulation of loading test specifications: the *acceptance test*, the *rating test*, and the *research test*. Each test has its own purpose and specific requirements and all three types bear a close relationship to each other.

The *acceptance test* is designed primarily to prove the structural adequacy of a completed structure or part thereof. Such a test may be required by the building official or owner when

DONALD B. DOREY has been with the Division of Building Research of the National Research Council of Canada for four years, during which time he has been engaged in planning, conducting, and analyzing results of loading tests.

WILLIAM R. SCHRIEVER has been associated with the Division of Building Research of the National Research Council of Canada for eight years and lately engaged in studies of the performance of structures and building design.

* Presented at an open meeting of ASTM Committee E-6 on Methods of Testing Building Constructions held June 29, 1955, during the 58th Annual Meeting in Atlantic City, N. J.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

TABLE I.—BUILDING CODE—LOADING TEST SPECIFICATIONS.

Authority	Material	Type of Test	Time of Test	Superimposed Test Load	Duration of loading, hr	Requirements After Loading	Requirement on Removal of Loading
National Building Code-National Research Council of Canada	Concrete	Strength	Not Specified	1½ live load	24	No signs of weakness or of faulty construction	75% recovery of max. deflection on first test or 75% recovery of max deflection shown during second test
British Standard Code of Practice CP 113 (1948)	Steel	Stiffness	Structure should be loaded with actual dead load for as long as possible before testing	Stiffness: 1½ live load	24	Maximum deflection—not excessive	80% recovery of deflection on first test or 90% recovery of deflection on second test
		Strength		Strength: 2 live load + dead load For 2-story dwellings and schools, 2 live load Wind load: 2 wind load with or without vert. load	24		20% recovery of deflection
British Standard Code of Practice CP 114.100-114.105 (1950)	Concrete	Strength	56 days to be allowed for hardening of concrete	1¼ design live load	24	No evidence of failure	75% of recovery of deflection on first test or 75% recovery of deflection on second test
American Concrete Inst. Building Code (ACI 318-51)	Concrete	Strength	Not specified	2 live load + ½ dead load	24	No signs of failure. Limiting deflection $D = L^2/12\,000t$*	If D is exceeded, residual deflection 24 hr after removal of load must not exceed 40% of max deflection observed under load or 60% of D. Deflection must not exceed $3D$ under load
Uniform Building Code-Pacific Coast Building Officials Conference	Steel	Strength	Not specified	2 design load	No time specified	Sustained load without failure	Determination of elastic properties should be based on deformations at (*1*) 75% of max load which can be sustained or (*2*) a total load equal to 1 design dead load + 1½ design live load, whichever is the larger
		Performance		1½ design live load + ½ design dead load	No time specified	Local distortions should not develop	
Basic Building Code-Building Officials Conference of America, Inc.	All construction materials	Strength	Not specified	2½ live load	No time specified	Sustain load without failure	.....
		Performance		Approved working load	No time specified	Limiting deflections under working load not to exceed: (*1*) 1/360 of span for plaster (*2*) 1/240 of span, unplastered floor construction (*3*) 1/180 of span for unplastered roof Construction	.....
		Workmanship	Not specified	2 live load	24	No signs of failure. Total deflection not to exceed theoretical deflection calculated from accepted engineering formulas	If computed deflection is exceeded, structure must recover 75% of max deflection within 24 hr of removal of test load

* Where D = the maximum deflection of the portion of the structure under test, L = the span of the member under test between faces of supports, and t = the depth of the member under test.

TABLE I—(Cont'd)

Authority	Material	Type of Test	Time of Test	Superimposed Test Load	Duration of loading, hr	Requirements after loading	Requirement on Removal of Loading
Southern Standard Building Code-Southern Building Code Congress	Concrete	Strength	Not specified	1½ live load + ½ dead load	24	No signs of failure. Limiting deflection, $D = 0.001L^2/12t$*	If D is exceeded, structure must recover 75% of observed deflection within 24 hr of removal of test load
	Prefabricated construction (panels)	Strength	Not specified	2½ live load	24	Sustain load without failure	75% recovery of observed deflection within 24 hr after removal of full test load
		Performance		1 live load	...	Measured deflection shall not be more than 1/360 of clear span	.....
National Building Code-National Board of Fire Underwriters	All materials	Strength	Not specified	Not less than 2 design live load	No time specified	.....	75% recovery of max deflection within 24 hr of removal of test load
Chicago Building Code and Index-City of Chicago	All materials	Workmanship	Not specified	2 design live load	24	No signs of failure. Total deflection not to exceed that calculated by theoretical engineering formulas	If calculated deflection is exceeded, structure must recover 75% of observed deflection within 24 hr of removal of test load
State Building Construction Code-State of New York	All materials	Strength	Not specified	2 uniformly distributed imposed load	24	Sustain load without failure	.....
		Performance	Not specified	1 uniformly distributed imposed load	No time specified	Limiting deflections: (*1*) 1/360 of span for plaster (*2*) 1/240 of span, unplastered (*3*) 1/180 of span for unplastered roof construction	.....
		Performance	Not specified	1½ uniformly distributed imposed load	No time specified	Sustain load without structural damage	For floor assemblies, residual deflection after first test shall not exceed 25% max deflection under load. Residual deflection on second test not to exceed 1.1 residual deflection from first test
New Zealand Standard Code of Building By-Laws-New Zealand Standards Inst.	Concrete and Steel	Strength	Ample time to be allowed for hardening of concrete before test	150% of load for which structure has been designed	No time specified	No signs of failure	.....
Uniform Building Regulations-Melbourne, Australia	All materials	Strength	Not specified	1½ live load + ½ dead load	24	Limiting deflection at the end of 24-hour period, $D = 0.001L^2/12t$*	If D is exceeded, structure must recover at least 75% of observed deflection within 24 hr after removal of test load
Model Building Regulations of South Africa	Concrete	Strength	28 days after concrete is placed or on date agreed upon	Slab or beam: 1½ design live load + ½ dead load	24	No evidence of failure. Limiting deflection at the end of 24-hr period, $D = L^2/12\,000t$* D.B.R. Dwg.* BR 602	Residual deflection not to exceed ¼ max deflection at the end of 24-hr period. If there are no signs of failure and allowable deflection was exceeded on first test, second test may be carried out after 72 hr have elapsed

the structure is incapable of accepted analytical design or when a change in occupancy is requested for an older structure. The purpose of the acceptance test, therefore, is to prove the present quality of the structure and to give a reasonable assurance of safety for the future under normal use.

The *rating test* is designed, primarily, to assist the building official in assigning an allowable load to a particular type of construction, especially new types of construction that are mass produced. The rating test must, therefore, allow for the variability of the specimens in view of the fact that only a certain percentage of all the specimens are tested.

The *research test* is a scientific investigation of the performance of a structure under loading up to and including collapse to correlate actual stresses and displacements with those obtained by calculation or other methods in the design.

An important difference between the acceptance test and the rating test and the research test is that in the former, one is not normally concerned with the economy of the design. The acceptance test serves only to establish that a minimum of strength and stiffness is provided, whereas the rating test (when carried to failure) and the research test, by exposing the load factor of safety through failure, may indicate overdesign and thus provide the designer with a direct tool for economic design.

Two aspects of the performance should be distinguished, strength (or safety against failure) and stiffness (or absence of objectionable deflections under working loads). In some cases a structure designed for a required strength will automatically exhibit a satisfactory stiffness; in other cases it will not.

It is essential that a balance be kept between the requirements for design and those for loading tests, otherwise a properly designed structure may either not pass the loading test or the loading test may sanction an underdesigned structure. The choice of magnitude of the various test loadings is, therefore, very important. Any improvement or refinement in loading test specifications must keep pace with the status of design specifications. However, a loading test specification must be kept simple enough to be used and administered without undue difficulty.

Factors to Be Considered in Formulating Loading Test Specifications

The factors to be considered in formulating test loadings for structures are many, and they depend upon the type of construction and the intended use of the structure. If, for instance, the type of structure is one in which overloading would endanger human lives by failure without warning, such a structure should be subjected to a rigorous loading test schedule involving all possible alternatives in loading. The greater the number of factors entering into the design assumptions, the more important it is to know how that structure will react to the forces acting upon it during its period of useful service, and the more essential it is to arrive at the proper test loading and test procedure.

Sometimes the authorities responsible for a loading test are hampered by the lack of important information necessary for the proper conduct of the test. For example, a loading test may be required on an existing building for which there are no longer any detailed plans.

The factors which should be taken into account in a loading test specification include the following:

Classification of Structures

There are two main groups into which structures may be classified, namely, statically determinate structures, which are relatively simple and straightforward to design, and statically indeterminate structures, which are more complex and in the design of which more assumptions must be made before a theoretical analysis is possible. When the complexity of the calculations discourage efforts of theoretical analysis, the designer may often find it necessary to resort to other methods. In such instances, a loading test is a desirable and important means of assessing the strength and stiffness of a structure.

Many statically indeterminate structures display a reserve of strength after initial relaxation occurs at the joints. Under such conditions of apparent overstressing at the joints, the recovery of deflection will be poor, yet the structure may, if made of ductile material, still be quite safe. In other words, if loading is continued beyond the yield point, additional loading is required to produce failure due to a redistribution of moments. Under similar circumstances of overstressing, however, collapse would likely occur much earlier in the loading in a statically determinate structure.

Intended Use of Structure

If clearly defined, the intended use of a structure will normally dictate what its strength and stiffness should be. A properly designed structure must meet both a standard of strength and a standard of stiffness, but the standard of strength may be so high that the stiffness requirements are achieved without special attention or *vice versa*.

The risk of failure, that is, the losses in human lives and valuable property which would result from failure depends upon the use and occupancy of the structure. The risk involved is far greater in structures designed for public use than it is in structures designed for dead storage. The designer must, therefore, govern his design accordingly from a strength point of view. In respect to stiffness, the designer must also produce a design which, when considered in relation to occupancy and use, will not deform to the extent of causing damage to decorative finishes.

It would not only be desirable to design a structure for a given load limit but also to give it a "design life." Unfortunately, however, it is difficult to assign a definite period of time to the life of a structure. Until such time as sufficient knowledge is accumulated, the useful life of a structure is governed by the loads, or, more generally, the intended use of the structure.

Materials of Construction

The strength and stiffness of a structure during its period of intended use or design life cannot be disassociated from the quality of the materials that go into the construction. For example, a brittle material such as stone, concrete, and even some metals may fail suddenly, whereas a ductile material will usually deform extensively before failure. Many materials are affected by changes in moisture content both in their load-carrying capacity and in their susceptibility to deterioration.

Steel is susceptible to corrosion unless protected. When corrosion takes place, expansion may occur in connections which may stress appreciably the connecting media and promote premature failure. Corrosion of even the simplest sections of steel is detrimental to their strength during the design life of a structure. The danger of failure is reduced when we consider an exact duplicate of a mild steel structure in an identical environment if the second structure is constructed of stainless steel. The stainless steel structure should not be loaded as severely in a loading test.

The physical and chemical properties of a material form a basis for forecasting the type of failure to be expected; that is, failure may be the result of simple overstressing, or the result of chemical decomposition followed by overstressing of the reduced cross-sections. Failures may also occur in

fastenings or bonding of materials leading to collapse by the same processes.

Standard of Workmanship

An equally important consideration in respect to the strength and stiffness of a structure is the standard of workmanship maintained during construction. There are many structures where there is little cause for concern because of the nature of the construction while, on the other hand, there are numerous structures where the required strength and stiffness is achieved only by good workmanship and close supervision. Workmanship is particularly important in the field of concrete construction and wood construction. Variability is recognized in good concrete design as being something which cannot be completely overcome. For instance, even under close supervision, reinforcing rods are not always placed in their correct position. Another example is that of composite construction which usually requires a high standard of workmanship during fabrication.

The authors do not advocate that every structure should be penalized during loading tests for inferior workmanship but that extra caution should be exercised where the quality of the workmanship may seriously affect the performance of a structure either directly or indirectly during its design life.

Design Loads and Actual Loads

The recommended design loadings are the minimum values that a designer is allowed to use where a local building code applies. These values are accepted as being representative of actual conditions of use and occupancy. The engineer and architect know, however, that there are many instances where these values are exceeded under unusual circumstances, whereas in other instances the design loadings are never reached. From studies that have been made on floor loadings it has been determined that as the area of a floor is increased, the magnitude of the average loading per unit area decreases. Small areas may be required to sustain nearly twice the recommended design loading whereas larger areas normally support smaller loadings than those specified in the local building code. The contents of libraries, warehouses, and office buildings often induce loadings which are in excess of design loadings. It is therefore suggested that recognition be given to the probable degree of overloading any given structure may have to sustain when considering the magnitude of the test loading. Recognition of this probable overloading with respect to recommended design loadings might apply not only to new structures where there is doubt as to their structural adequacy but also to structures where a change in use or occupancy is requested. This recognition is to acknowledge that it is impossible to police all buildings for changes in use or occupancy.

Overdesign for Special Reasons

Overdesign is not unusual, particularly in structures in which the yield stress would otherwise be reached or exceeded during construction. This applies more specifically to buildings. designed for small live and dead loads. Unusual soil conditions may warrant overdesign as a safeguard against differential settlement. Changes in temperature and moisture conditions may also justify overdesigning. Areas subject to earthquakes will necessitate special consideration of the more vulnerable components. Overdesign for the reasons just mentioned does not mean that such structures should be expected to give any added performance during a loading test unless this performance is specified as a requirement and is related to the use and occupancy.

Types of Failure

Failures in structures can be classified into three possible types: (*a*) failure without warning, (*b*) failure occurring after yielding has taken place at a certain load, and (*c*) failure to a state of unserviceability at a certain load but still safe. This classification may appear to be an attempt to oversimplify the actual conditions under which failure occurs, but when the question of risk and the consequences of failure are considered, this means of reference seems justified.

The first type of failure listed, which is typical of brittle materials, is the most dangerous especially when human lives are involved. Before acceptance is given to a structure of this group, especially for public use, extreme caution must be exercised. The second type of failure calls for careful attention, but such failures are not as dangerous as the first type. This type of failure gives a warning of impending collapse.

The third type of failure is the least hazardous. A structure which will behave in this manner under critical loading conditions is said to be ductile, or tough. Where extra precautions against collapse are necessary, this type of structure is preferred. The distortion of the physical shape under critical loadings may render the structure unserviceable; but the safeguard against complete and abrupt collapse eliminates much of the risk common to the first two types.

Factor of Safety

The expression, "Factor of Safety," unless clearly defined can mean either "stress factor of safety" or "load factor of safety"; therefore, a distinction must be made between the two meanings. When we are concerned with the total live load which a structure can sustain without collapsing the expression "load factor of safety" expresses precisely either the theoretical or the actual load that a structure can support divided by the design load, whereas the "stress factor of safety" is the ratio of the stress at failure to the allowable stress of the material used in the structure. The approach to design, particularly in steel and in reinforced concrete, from considerations of failure conditions rather than from the allowable stress criterion, is one of the most important recent developments in engineering and promises considerable economic advantages combined with the actual degree of safety desired. "Limit design" has not yet been adopted in codes in the United States or Canada, whereas it is being used in a number of European and South American countries. There is no doubt, however, that the effect of stress redistribution by plastic flow on the strength of a structure can no longer be ignored, and this consideration will sooner or later enter the codes.

Risk of Failure

The risk of failure or the amount of loss which would result from failure is another factor requiring elaboration. Partial or complete collapse of a structure may be the result of poor design or the result of any number of factors, some of which have been discussed earlier in this paper. The term "risk of failure" in this paper does not mean any possible damage to a structure, such as damage of interior finishes, but is intended to mean the potential danger to human lives and valuable property during the period of useful service of the structure.

The risk of failure is related, among other things, to the type of failure. A failure occurring without warning is much more serious in the case of a grandstand structure supporting a large crowd of spectators than it is in the case of a structure used for dead storage remote from any public or private gatherings. The risk of failure therefore may be much less when the "load factor of safety" is three against failure of the third type than it is when the "load factor of safety" is five against failure of the first type.

Duration of Loading

Generally, most structures subjected to long-term loading tend toward continued redistribution of stresses, accompanied by slow, but measurable, increases in deformation. This tendency, however, may not be of sufficient consequence to warrant concern unless the structure has been poorly designed, in which case, progressive deformation may lead to eventual collapse of the system.

Long-term loading considerations are of such significance in wood construction, for instance, that a decrease in strength is allowed for in most cases in the working stresses of the material. Conversely when the maximum load is of known short duration, advantage is sometimes taken of the increased strength characteristic by increasing the allowable working stresses.

Progressive deformation under long-term loading in an improperly designed structure can lead to a disruption of attached finishes. This form of secondary failure may be caused by creep in the structural material or through slippage between materials of composite construction. It is, therefore, important to recognize any possible weaknesses of this kind in a structure and take appropriate steps to bring such faults to light during a loading test.

The question then arises as to how long-term loading can be represented in a test of short duration. This question can only be answered in terms of allowable working stresses. When a long-term loading condition has not been considered in the selection of allowable working stresses, then an increase may be required in the magnitude of the test loading.

Repeated Loading and Vibration

Repeated loading and vibration are other factors worthy of attention in the formulation of loading tests. Recent developments in design indicate a trend toward the use of higher allowable stresses or a reduction in the over-all load factor of safety. In a structure designed for static loads, this tendency would appear to be justified. However, a reduction in the load factor of safety may be carried too far, for, if the working stresses are increased in respect to static loads, the fatigue strength of the material remains the same. If one structure is subjected to static loads only, whereas a second identical structure has to support dynamic loads, the second structure should be loaded more severely during a loading test because of the fact that fatigue may occur and appreciably shorten the intended design life.

A New Approach to Loading Tests

It has been shown that, in most instances, the existing full-scale loading test specifications lack adequate recognition of the various factors, in accord with the present state of knowledge. This fact may be confirmed by a critical review of existing specifications. The variation shown in the magnitudes of test loadings suggests that rather arbitrary figures have been chosen. It appears that there is no defined process by which the magnitude of the test loading is derived, other than by assuming a certain multiple of the design load, plus a portion of the dead load in some instances. As economy plays so important a role in engineering and architectural design, this method of judging structural adequacy must be questioned.

Modern tools of research and contemporary knowledge afford almost unlimited possibility for precision in determining the behavior of a structure undergoing a loading test. Present specifications properly stress the importance of deflection and recovery after unloading, but fail to agree on the allowable deflections or on the required amount of recovery after unloading.

The strength and stiffness of a structure depend upon a number of factors as previously mentioned. It is difficult to separate any one factor and test the structure for that factor alone. The authors believe, however, that it is possible to arrive at a loading test specification which, based on a quantitative assessment of the various factors affecting the strength and stiffness of a structure, will enable those who are responsible for loading tests to choose an appropriate magnitude of the total test loading for a specific structure.

The question then arises as to how to make up a loading test to include all the pertinent factors relative to assessing the structural sufficiency of a structure.

A Proposal on the Formulation of Test Loadings

The authors wish to emphasize at this point that the proposed outline in the following paragraph is a suggestion only and has been prepared as a basis for discussion.

The magnitude of the test loading in an acceptance test is made up of three parts which, when added together, make up the total test load to be applied to a given structure. The first part consists of the total live load plus any necessary dead load additions; the second part is a certain minimum overload expressed as a percentage of the total live load; the third part is an additional portion, expressed as the sum of individual percentages representing the factors which distinguish one structure from another (Fig. 1).

The first portion of the test loading indicated by *A* in Fig. 1 is 100 per cent of the design live load plus any additional dead load which may not be supported by the structure at the time of the test. If the test is required to approve a change in use or occupancy of an existing structure, portion *A* of the test load consists of the newly assigned live load only, unless renovations impose an additional dead load.

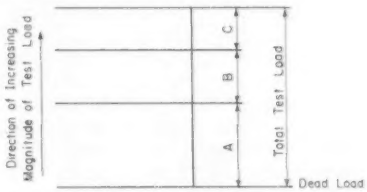

Fig. 1.—Formulation of Test Load

Acceptance Test

Part A of test load = 100 per cent live load + any additional dead load

Part B of test load = percentage overload from Fig. 2

Part C of test load = summation of percentages from Table I

Magnitude of total acceptance test load = A + B + C

Rating Test

Magnitude of total rating test load = A + B + C from Acceptance Test + percentage given in Table II

The second portion of the test loading indicated by *B* in Fig. 1 is a basic overload, expressed as a percentage of the live load. *B* depends upon the risk of failure and is a function of two independent variables, namely, use and occupancy (indicating the seriousness of a collapse) and the type of failure (or warning before failure). Figure 2 suggests a way of plotting this basic overload employing use and occupancy as an independent variable and the type of failure as a parameter. The use and occupancy ordinates vary with increasing risk. The three curves correspond with the types of failure expected and increase in severity of percentage of overload from type (*c*) to type (*a*). The percentage of overload to be applied to a given structure can be obtained by following the curve appropriate to the type of failure expected to the point where the curve crosses a horizontal line through the appropriate use and occupancy. The percentage of overload is then indicated by a vertical line through this point on the curve.

The third portion of the test loading indicated by *C* in Fig. 1 is the summation of applicable percentages of live load which take into account the material and such factors as workmanship, deterioration, fatigue, long-term loading, impact loading, and vibration. The applicable number of percentages varies

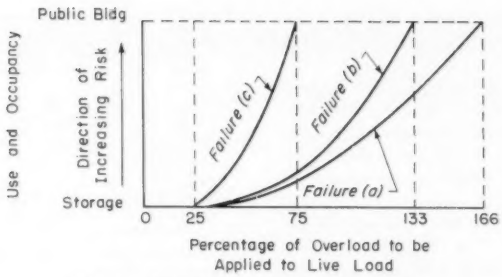

Fig. 2.—Acceptance Test and Rating Test

Percentage of live load to be used in Part B of test load

(*a*) Failure without warning

(*b*) Failure occurring after yielding has taken place at a certain load

(*c*) Failure to a state of unserviceability at a certain load but still safe.

with the type of construction and gives weight to the factors peculiar to a given structure. Values for these percentages could be listed in tabular form, giving numerical values for each of the factors just mentioned for different construction materials. These values should be selected by code-writing authorities in consultation with research organizations and industry.

The rating test differs from the acceptance test in that the magnitude of the rating test load depends upon the number of specimens represented by one test specimen. If every specimen were tested, the two tests would be identical, except that the rating test might be carried to failure. The rating test may be conducted on the site or in a testing laboratory. The variation in the strength of a given number of specimens would be taken into account by a probability factor expressed in terms of a percentage of the live load and would be added to part *C* of the acceptance test load. The choice of the value of this factor should be done on the basis of loading test statistics on similar materials and constructions. Values for these percentages could be listed in tabular form for each material, giving the values to be set also by the code-writing authorities in consultation with research organizations and industry for each of three conditions of speci-.nen selection. The suggested member of specimens selected would be in relation to three ratios, namely, 1 in 1 (acceptance test), 1 in 10, and 1 in 100.

Criteria for Assessing Structural Adequacy

The next consideration should be how to judge whether or not a structure has passed the acceptance or rating test. The acceptance and rating tests can be dealt with in the same manner, except for the test load (as for the rating test a higher test load is used depending on the number of specimens tested) and the fact that the rating test might be carried to failure.

The structure must meet one or both of the requirements of strength and stiffness. According to present design procedure (that is, excluding limit design), the strength requirement is met if, after the proper choice of the test loading, no point of the structure shows excessive stress (or strain) or imminent instability. Thus, in a loading test, the strains developed would have to be measured at all critical points and deformations would have to be determined in compression members and other places of possible instability. In some structures, such as complicated frameworks and thin-webbed members, this would call for elaborate instrumentation and is not practical in the case of the normal acceptance test because of the complications and the cost involved, and because of the possible inaccessibility of the critical points in the finished structure. Consequently, for the acceptance test, other means of assessing structural adequacy from the strength point of view must be obtained, using (*a*) deformation or deflection, (*b*) recovery of deflection after unloading, (*c*) signs of damage or distress, or a combination of these as a criterion.

Another question which must be decided is whether the same test loading should be used for strength and stiffness. This may not seem very important at first, as usually a structure should not reach yield conditions in the strength test so that we can assume that deformations are proportional to load. Thus it might seem of little consequence whether the deformations are measured at the design live load or at the test loading. The magnitude of the deflections at a loading corresponding to the design live load is of special interest however. The design specifications often state a maximum deflection under design live load. At this load the structure under test should also be checked for the absence of minor damages, such as cracks in plastered ceilings or walls, as such cracks could justifiably be allowed to occur at the higher loadings used for the strength test.

The authors believe that not one criterion, but a combination of maximum deflection and minimum recovery, coupled with the absence of any signs of distress in the main structural parts under the test loading, should be used as a strength requirement, whereas the stiffness requirement should consist of a maximum deflection and the absence of any signs of damage under one times live load.

Stiffness Requirement

Values of acceptable deflections or deformations should be formulated in the usual way as certain allowable deflection-span ratios, such as $\frac{1}{360}$ of the span as commonly used for floors.

During the application of one times live load, it should be ascertained that there are no signs of damage to either the structural members or the architectural finishes.

The actual values of acceptable deflections and deformations would have to be selected by code writing authorities based on recommendations by a committee of experts.

Strength Requirement

As already mentioned, the recovery of deflection after the removal of the total test loading is normally the most simple means of detecting whether the structure has exceeded the yield point. If, however, the observation of recovery and of possible signs of failure is not considered to be sufficiently indicative of satisfactory structural performance, the building official may require strain and deformation measurements to be made by accepted methods at critical points of the structure to prove that no excessive strains or signs of instability are occurring at these points.

The total test load should be sustained by the structure being tested for a minimum period of time, such as 24 hr, without any signs of structural failure. After removal of the test load the recovery within 24 hr from the beginning of the unloading should be a minimum percentage of the deflection under the test load, for instance, 75 per cent.

If the structure does not pass this test but shows a minimum recovery of, say, 60 per cent, retesting should be allowed. Some of the residual deflection after the first loading normally is of no serious consequence as it is due to "bedding down" at supports, joints, etc. The retesting should be started as soon as possible and the total test load should again be applied for at least 24 hr. After unloading the recovery with-

in the following 24 hr from the beginning of the unloading should be almost complete, say 90 per cent of the deflection measured during the second loading.

These recovery figures should, of course, be adapted to different types of construction and materials taking into account such factors as creep of the material under load.

If the amount of creep which is estimated to develop in the structure under service conditions, is considered to be of consequence, the building official might require that the loading period be extended and that the deformations be measured at intervals under load to permit plotting of the time deflection curve.

Other Considerations

A number of details of the testing procedure should also be covered by a loading test specification. Among these are the required refinement and accuracy of the measurement of deformation, the minimum and maximum age of a new structure at the time of testing, and special conditions such as the selection of specimens for the rating test.

Further details of a specification might relate to the following: The loads should be applied in increments of a given fraction of the design live load and the deformation should be measured after each load increment has been in position for a given time. In the rating test each of the specimens should satisfy the strength and stiffness requirements. After unloading, each specimen should be reloaded and the loading continued in regular increments until failure occurs. The complete load deformation curve and a detailed description of the way in which failure occurred should be submitted to the appropriate authority.

Conclusion

An attempt has been made in this paper to draw attention to the shortcomings of existing loading test specifications and to combine some principles outlined by the authors in a philosophy on loading tests which, in its broader aspects, will be in closer harmony with the present state of scientific knowledge. The authors, although conscious of the difficulties which lie ahead in the task of evaluating the various factors and in choosing numerical values believe that the views and principles incorporated in this paper are shared by many who are interested in the safety and efficiency of structures.

The authors are encouraged in this belief by many references in papers such as those listed at the end of this paper, and in particular by the following quotation from the Report of the British Building Research Board for the year 1953.

"In recent years there has been an increasing tendency for structural engineers to consider a new approach to design. In this, the old method of checking that the stresses throughout a structure, for the assumed conditions of working load, are less than certain permissible values, is largely abolished. In its place a design philosophy is being developed of which the main principles are (*1*) that the load that will just cause failure of the structure is sufficiently greater than the working load, so that the probability of failure during the required life of the structure is less than a specified limit, (*2*) that for working-load conditions through the required life, the deformations of the structure shall not be such as to impair its safety or efficiency, and (*3*) that economic considerations in the design of structures shall include full allowance for the need for, and cost of, maintenance during the life of the structure."

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Choice of Background for Detergent Efficiency Evaluation

By D. W. Stephens and C. B. Brown

THIS PAPER reports the results obtained in evaluation of detergent efficiency of four detergents by measuring the reflectance of cotton test pieces for five backgrounds. A paper by Diaz, Paitchel, and Woodhead[1] indicated the need for a standardized procedure for measuring reflectance of detergency fabrics. In these laboratories,[2] consideration has long been given to the effect on detergent efficiency evaluation of factors such as background reflectance. A Hunter Multipurpose Reflectometer with green filter was used to make the reflectance measurements.

As mentioned in the paper referenced above, positioning has an important effect on the measurement of fabric reflectance. For many years, the practice in these laboratories has been to make two measurements of the reflectance of each surface of a test piece, one with the warp threads vertical and one with them horizontal. Typical reflectance readings obtained for seven test pieces are given in Table I.

In the laboratory assessment of the efficiency of a detergent, reflectance measurements are made of unsoiled cloth, soiled cloth, and washed cloth. The detergency index is then calculated from the expression:

$$\text{Detergency Index} = \frac{R_W - R_D}{R_C - R_D} \times 100$$

where:

R_C = reflectance of clean or unsoiled cloth,
R_D = reflectance of soiled cloth, and
R_W = reflectance of washed cloth.

The 4 by 5-in. test pieces used in our detergency experiments of the past few years have precluded folding test pieces to obtain several thicknesses for measurement in the Hunter reflectometer. A special backing procedure has therefore been used. The procedure consists of measuring the reflectance of soiled and washed test pieces backed with a piece of pale cream xylonite of 68.0 per cent reflectance. The reflectance of clean, unsoiled cloth is measured with a backing of eight thicknesses of the same cloth, equivalent to a reflectance of 88 per cent.

For standardization of detergency index evaluation the authors recommend a white background.

The fabric usually used for detergency work in our laboratory is a light weight, plain-weave cotton with 120 threads to the inch. Use of different background material has a marked effect on the reflectance value obtained for a single layer of this fabric. To illustrate this effect, five backgrounds were used:

1. A *black* enameled plate, reflectance 0.5 per cent.
2. A pale cream-colored *xylonite* plate, reflectance 68.0 per cent.
3. A *"white"* enameled plate, reflectance 88.1 per cent.
4. A *"nearest"* background consisting of an enameled plate with reflectance as near that of the sample being measured as could be judged visually.
5. A *"special"* background consisting of a xylonite plate of 68.0 per cent reflectance for the measurement of soiled and washed test pieces and eight folded thicknesses of clean cloth for the measurement of unsoiled test pieces.

The test material was prepared in the following manner:

The fabric was desized and the reflectance was measured with the backgrounds described above. The cloth was then soiled by hand with a suspension in carbon tetrachloride of solvent-extracted domestic vacuum-sweeper dust and oil. The oil used is similar to that found on domestic articles.[3] Test pieces, 4 by 5 in. were cut from the soiled cloth and the reflectance of each piece measured for each of the five backgrounds. Different test pieces were then submitted to a

TABLE I.—REFLECTANCE OF TEST PIECES, PER CENT.

Test Piece	First Surface		Second Surface		Average
		Turned Through 90 deg		Turned Through 90 deg	
No. 1	35.8	37.4	36.0	37.8	36.8
No. 2	36.6	38.6	36.2	38.0	37.4
No. 3	35.0	36.8	35.6	37.6	36.3
No. 4	40.0	41.8	40.6	43.0	41.4
No. 5	54.4	56.4	54.4	57.0	55.6
No. 6	63.6	65.6	63.2	66.0	64.6
No. 7	70.0	71.0	70.0	71.8	70.7

D. W. STEPHENS, (left) and C. B. BROWN, (right) are both research chemists who have been working for many years on problems in detergency and allied subjects at Unilever Research Laboratories, Port Sunlight, England.

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[1] R. B. Diaz, H. Paitchel, and J. A. Woodhead, "Need for a Standardized Procedure for Measuring Reflectance of Detergency Fabrics," ASTM BULLETIN, No. 202, Dec., 1954, p. 56.

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[3] C. B. Brown, Research, 1947, I, 46.

TABLE II.—SUMMARY OF RESULTS, USING FIVE DIFFERENT BACKGROUNDS.

Detergent Solution	Average Reflectance, per cent[a]									
	Soiling No. 1					Soiling No. 2				
	Black	Xylonite	White	Nearest	Special	Black	Xylonite	White	Nearest	Special
	Unsoiled Fabric (R_C)									
	61.8	76.4	87.2	87.2	87.2	61.8	76.4	87.2	87.2	87.2
	Soiled Test Pieces (R_D)									
	37.1	38.6	39.2	38.1	38.6	36.3	37.8	38.5	37.3	37.8
	36.9	38.4	39.4	37.9	38.4	36.9	38.4	39.1	37.9	38.4
	36.8	38.2	39.1	37.6	38.2	36.8	38.2	39.2	37.7	38.2
	37.4	39.1	40.1	38.6	39.1	36.2	37.9	38.9	37.4	37.9
	Washed Test Pieces (R_W)									
A	42.1	45.0	46.3	43.9	45.0	41.4	44.1	45.2	42.7	44.1
B	43.7	47.3	48.9	46.1	47.3	43.5	46.8	48.0	45.7	46.8
C	53.1	60.7	64.6	60.0	60.7	52.7	59.8	63.8	59.3	59.8
D	55.6	65.2	70.7	63.9	65.2	54.6	64.0	69.1	63.0	64.0
	Detergency Index									
A	20	17	15	12	13	20	16	14	11	13
B	27	23	20	17	18	27	22	19	16	17
C	65	59	53	45	46	64	57	51	44	44
D	75	70	65	52	54	72	68	63	51	53

[a] The reflectance measurements are the means of four readings on each test piece, two on each face; one with the warp threads vertical and one with the warp threads horizontal.

TABLE III.—RELATIVE DETERSIVE EFFICIENCY, PER CENT, USING FIVE DIFFERENT BACKGROUNDS.

Detergent Solution	Black	Xylonite	White	Nearest	Special
D	100	100	100	100	100
C	88	84	81	86	84
B	37	33	30	32	33
A	27	24	23	22	24

standardized washing test containing one of four detergent solutions, A, B, C, or D, each free from fluorescent material. The reflectances of the washed and dried test pieces were then measured for each of the backgrounds. A complete series of tests was carried out on each of two soilings. The results are recorded in Table II.

Table II shows that variation in background has a relatively small effect on reflectance of soiled cloth (maximum difference 2.7 per cent) but has a marked effect on reflectance of unsoiled fabric (25.4 per cent) and washed test pieces (15.1 per cent). Consequently, a difference is also observed in the computed detergency index.

The detergency index of superior as well as inferior detergents varies with background reflectance. The magnitude of detergency-index variation for different detergents is most easily compared by assigning a value of 100 to the detergency index of the best detergent or of a standard detergent. Other detergents can then be rated relative to the standard on the basis of their relative detergency index or what might be called relative detersive efficiency. This likewise is a function of background reflectance. The question we wish to resolve is this: For a given test fabric, which background will give the greatest range in relative detersive efficiency between a good and a poor detergent? The relative detersive efficiencies of Table III have been computed for each background by averaging the detergency-index values for the two soilings of Table II.

We see immediately the white background provides maximum differentiation in relative detersive efficiency. Table III also shows that the use of a black background gives the smallest differentiation in relative detersive efficiency.

Only one type of cotton fabric has been used in these experiments. However, a cloth of more open weave would be expected to show an even greater variation in relative detersive efficiency for the same change in background reflectance.

When the washed cloths are examined visually against a black background, the cloths washed with detergent D appear to be slightly lighter than those washed with detergent C. When examined against a white background, the lightness difference between cloths washed with detergents C and D is much greater. These observations correlate with the reflectances and with the ranges of relative detersive efficiency computed for these background conditions. In practice, white articles are most often viewed when folded or placed on light-colored articles. Furthermore, it is evident that a white background affords a more stringent test condition than does a black background. Therefore, for standardization of detergency index evaluation a white background is recommended.

Vibrating Reed Test for Plastics

By Stephen Strella

The author describes a new vibrating reed method for obtaining the dynamic modulus of solid plastics.

THE IMPORTANCE of the dynamic moduli of solid plastics has been discussed in numerous articles (1).[1] This paper deals both with development of apparatus for performing vibrating-reed tests on plastics and with analysis of the data to provide valid dynamic moduli.

A number of dynamic tests in which the stress or strain is applied sinusoidally have been described. All these methods permit determination of both the real and the imaginary components of the dynamic modulus, usually designated E' and E''. Some of these tests are based on many assumptions—some are empirical, some require excessive lengths of time for either testing or sample preparation, and others are exceedingly complicated and expensive. However, one of these, the vibrating-reed test, appeared rather promising.

In the vibrating-reed test method originated by Nolle (2), a relatively long, thin specimen was vibrated by a magnetic recorder head. The frequency of vibration of the reed was varied, and the amplitude of the free end of the reed was measured with a telemicroscope. A plot of amplitude *versus* frequency was then made from which both the resonant frequency and the band width were determined. Band width here is the difference in those two frequencies at which the reed amplitude is 0.707 of the amplitude at resonance. Nolle assumed that the sample behaved as a given Voigt model[2] over the bandwidth frequencies. Applying the analogy of an electrical circuit, Nolle then calculated approximately the real and imaginary components of the modulus from the resonant frequency, bandwidth, density of the test material, and dimensions of the reed.

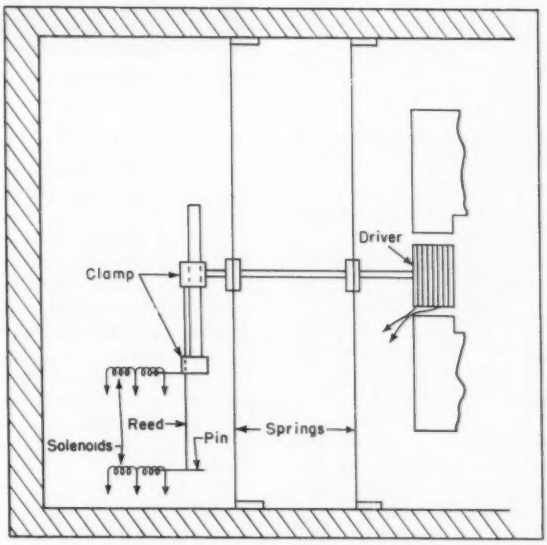

Fig. 1.—Schematic of Vibrating Reed Mechanism.

The idea of a vibrating cantilever is mechanically simple, and the range of frequencies were in the range of interest. However, some objections to the test method were apparent. These were: (1) $\frac{1}{2}$ to 1 hr was needed to obtain the experimental data for determining the amplitude-frequency curve for a particular reed length, (2) the clamp amplitude had to be constant over at least the bandwidth frequencies, (3) it was assumed that the material did not fatigue during the test, (4) the measurement of the thickness of the reed could be a source of large error in the dynamic modulus, since the thickness was only 0.010 in. and thickness squared entered into the calculations, (5) errors were introduced due to the graphical methods used to determine the resonant frequency and bandwidth and due to the use of the telemicroscope to measure amplitudes, and finally (6) a Voigt model was used in the analysis of the reed motion.

If these objections could be removed, the test method would be greatly improved. The remainder of this article deals with how the method was developed and how the objections mentioned above were met.

Figure 1 shows the vibrating-reed mechanism developed in the author's laboratory. A rod on which the clamp is mounted is supported near its ends by two springs. The springs are copper-beryllium strips, 10-mil thick, 1 in. wide, 7 in. long. They are bolted at each end to a solid support. The rod extends through the center of the strips perpendicular to the width. The use of this type of spring assures uniaxial motion of the rod.

Figure 2 shows an oscillograph of

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] Sometimes referred to as a "Kelvin model."

both the reed and clamp motion. Use of an L shape leaf spring, for example, introduced a vertical as well as axial movement to the rod. Hence the grip was not moved with true simple harmonic motion, and the analysis applied to the reed was invalid. At the other end, the rod is coupled to an aluminum cylindrical coil form on which is wound a coil. This coil protrudes into the magnetic field of a speaker type permanent magnet in the manner of Nielsen's vibrating reed setup (**3**). The output of an audio oscillator, amplified by a 30-w amplifier is introduced into this coil, producing linear motion of the rod and thus of the clamp.

A reed 5 in. or $2\frac{1}{2}$ in. long is mounted in the specially designed clamp. The special feature of this clamp is that it allows changing the free length of the reed and thus altering its resonant frequency without cutting the specimen or removing it from the clamp. At full extension, the clamp is $2\frac{3}{8}$ in. long and its resonance at this extension is above 500 cps.

By observing Fig. 1, it can be seen that the iron pin cemented to the free end of the reed extends into the core of an air core solenoid. As the reed vibrates, the pin moves in the core with a motion corresponding to that of the free end of the reed. The motion of the pin causes the inductance of the solenoid to change, the changes being proportional to both the frequency and the amplitude of motion of the pin. With a direct voltage across the solenoid, the changing inductance induces an alternating voltage in the solenoid which is proportional to the amplitude and frequency of the free end of the reed motion. By calibrating this induced voltage with a known frequency and amplitude of reed motion, the reed amplitude at any frequency may be known by simply measuring the corresponding induced voltage. It should be pointed out that when the free length of the reed is changed by the clamp the sole noid calibration value does not change, since the pin position is unchanged.

A similar solenoid setup is used to determine the amplitude of the clamp of the forced end of the reed. The coils used were obtained from Western Electric relays type 275A. Actually the solenoids are made up of two of these coils placed in series with magnetic fields opposing each other with approximately 90 v dc across them. This eliminates the stray voltages induced in the solenoids. The measured induced voltage is taken from the coil in which the pin moves.

Accurate vacuum-tube voltmeters having logarithmic scales were used to measure the voltages. These meters

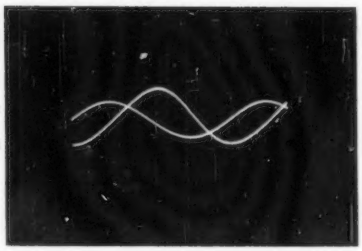

Fig. 2.—Oscillograph of Reed, *a* and *b*, Motion.

allow readings to be taken to within 1 per cent with $\frac{1}{2}$ per cent changes being detectable.

Thus by reading the voltages of the two solenoids at various frequencies of reed motion one could more rapidly determine the necessary data for obtaining the amplitude-frequency curves than is possible by optical methods. The first three objections that is, the long testing time, the necessity for constant clamp amplitude, and the possibility of fatigue, were thus bettered but not removed.

The reed drive system is sufficiently powerful to vibrate thick samples. By using a reed 0.1-in. thick with thickness tolerances of ± 0.0005 in., the error in modulus from this measurement can be reduced to less than ± 1 per cent. Thus, the fourth objection, based on the large percentage error in measuring a 10-mil specimen, is removed.

However, the remaining objections were still present, with an added one of having a mass on the end of the reed for which no correction had been made. These objections could be removed by performing a completely new mathematical analysis of the reed.

By assuming that the material's mechanical behavior could be described by a Voigt model, a fifth-order partial differential equation was derived from the motion of a cantilever beam. Using the applicable boundary conditions, this differential equation was solved for E' and E'' in terms of the reed motion. (See Appendix for solution.) The equations for E' and E'' are:

$$E' = \frac{12\rho\omega_R\,[l^4 + (4m_p/\rho s)l^3]}{d^2} \times \left[\frac{16}{16a_0^2 - F^2}\right]^2 \quad \ldots (1)$$

$$E'' = \frac{12\rho\omega_r^2 F\,[l^4 + (4m\rho/\rho s)l^3]}{a_0^3 d^2} \times \left[\frac{16}{16a_0^2 - F^2}\right]^2 \quad \ldots (2)$$

$$\text{Tan } \delta = \frac{E''}{E'} = \frac{F}{a_0^3}\left[\frac{16a_0^2 - F^2}{16}\right] \quad \ldots (3)$$

where:

$$F = \frac{-5.478 + 2\sqrt{7.502 + 6.15M^2}}{1.689M^2}$$

M = ratio of free end to forced end amplitudes of reed at resonance,
ω_r = resonant frequency, radians per sec,
l = length of reed, cm,
d = thickness of reed, cm,
s = cross-sectional area of reed, sq cm,
ρ = density, g per cu cm,
m_p = mass of pin, and
a_0 = 1.875.

It is seen that the only experimental information needed to determine the dynamic modulus is the resonant frequency of the reed and the ratio of free to forced end amplitude of the reed at resonance. This ratio is called the magnification factor.

In order to effect a particular solution of the differential equation, a Voigt model was assumed. However, since all the necessary information is obtained at only one frequency, any other model could have been used to give exactly the same result. Thus, the equations are not dependent on proper choice of model for validity.

In order to obtain the necessary information, the operator simply varied the oscillator tuning dial until a peak voltage is indicated on the reed-solenoid voltmeter. He then notes this voltage and also the clamp-solenoid induced voltage at this resonant frequency. He then measures the resonant frequency accurately by using a strobotron frequency meter. These determinations require no more than two minutes of the operator's time. Of course the length of reed, density of reed material, etc., have been determined previously. It should be stated here that if the clamp amplitude were constant the resonance indicated by the voltmeter would be slightly higher than the actual reed resonance because the voltage is proportional to frequency. However, since the clamp amplitude of this type of drive system is inversely proportional to the frequency, the resonance indicated by the voltmeter is nearly the actual resonance of the reed.

It is calculated that for a material having a dissipation factor (tan δ) of less than 0.1 (which covers most plastic materials), and neglecting errors in physical dimensions, the value of E' can be determined with an error less than ± 1 per cent and the value of E'' to less than ± 4 per cent. The error in tan δ is ± 3 per cent regardless of dimensional errors. Relative values

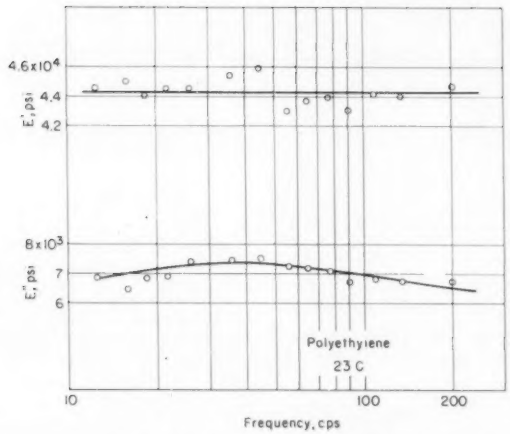

Fig. 3.—Dynamic Modulus - Frequency Behavior: Polyethylene.

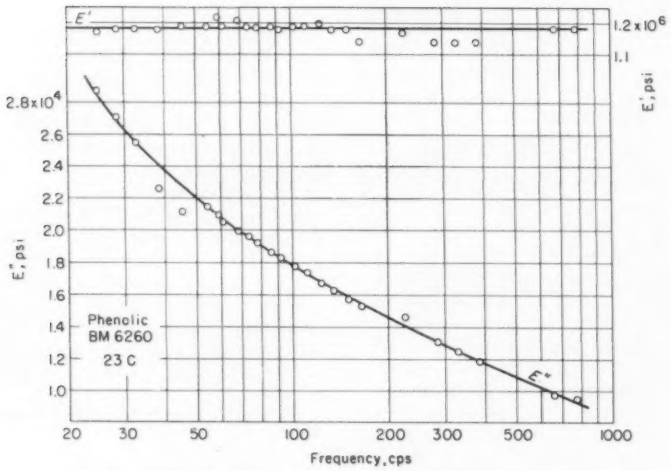

Fig. 4.—Dynamic Modulus - Frequency Behavior: Phenolic.

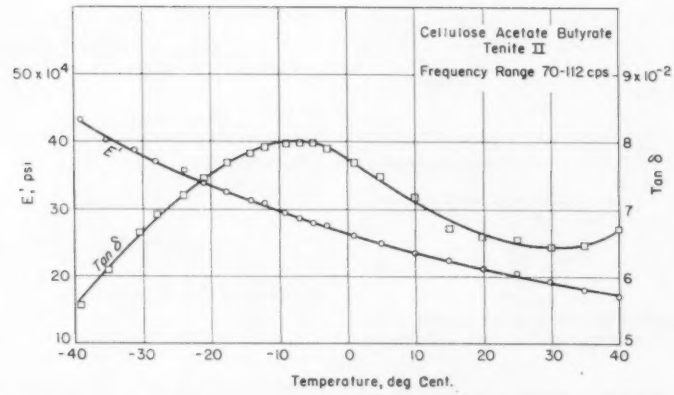

Fig. 5.—Dynamic Modulus - Temperature Behavior: Cellulose Acetate Butyrate.

of E', E'', and tan δ can be determined to within ± 1 per cent, ± 3 per cent, and ± 2 per cent, respectively.

The most significant error from dimension measurement is in measuring the reed thickness. Since the thickness is squared in the equations for E' and E'', it is imperative that uniformly thick samples be used in order to keep this error to a minimum.

The frequency range of the apparatus is approximately 20 to 500 cps, depending on the reed material. If a stiff material is used, for example a polystyrene, resonant frequencies as high as a thousand cps can be obtained easily by varying the length of the reed. It has been found that samples having thicknesses of 0.1 in. and 0.050 in. or 0.1 in. and 0.025 in. will cover the entire frequency range. If the information desired is limited to room temperatures and 150 cps, reeds of most solid plastics which are 0.1 in. thick will be satisfactory. The vibrating reed mechanism can be placed in a temperature cabinet if information is desired at various temperatures.

Figures 3 and 4 show some typical dynamic modulus data over the frequency range of the reed. Figure 5 shows some temperature data for a given reed length.

In summary, by using electrical means to measure clamp and reed amplitudes and with the new mathematical analysis, it is felt that all the serious objections to previous vibrating reed methods have been successfully met; that the developed method is fast, accurate, and inexpensive; and that its use as a laboratory tool for measuring the dynamic modulus can be recommended.

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APPENDIX

DERIVATION OF REED EQUATIONS

Assume that mechanical behavior of the reed can be described by a Voigt element. Then the moment for a reed hanging vertically is:

$$-M = E'K^2S\frac{\partial^2 y}{\partial x^2} + \frac{\partial^2}{\partial x^2}\left(\eta K^2 S\frac{\partial y}{\partial t}\right) \quad (4)$$

where:

S = cross-sectional area,
K^2D = moment of inertia,
x = coordinate along length of reed,
y = reed displacement at the x coordinate,
t = time,
E' = elastic modulus, and
η = coefficient of viscosity.

The shear force is:

$$V = \frac{dM}{dx} \quad (5)$$

The shear force derivative must be equal to the inertia forces:

$$\frac{dV}{dx} = \rho S\frac{\partial^2 y}{\partial t^2} \qquad \rho = \text{density of reed} \quad (6)$$

From Eqs 4 and 5:

$$\frac{dv}{dx} = \frac{d^2M}{dx^2} = -K^2E'S\frac{\partial^4 y}{\partial x^4} - \eta K^2 S\frac{\partial^5 y}{\partial x^4 \partial t} \quad (7)$$

Equating Eqs 6 and 7 we have:

$$E'K^2\frac{\partial^4 y}{\partial x^4} + \eta K^2\frac{\partial^5 y}{\partial x^4 \partial t} = -\rho\frac{\partial^2 y}{\partial t^2} \quad (8)$$

Letting $A = E'K^2/\rho$, $B = \eta K^2/\rho$.

Then Eq 8 becomes:

$$A\frac{\partial^4 y}{\partial x^4} + B\frac{\partial^5 y}{\partial x^4 \partial t} + \frac{\partial^2 y}{\partial t^2} = O \quad (9)$$

Assuming a solution $y = ze^{i\omega t}$, where z is a function of x only and by substituting for y into Eq 9 results in:

$$(A + i\omega B)\frac{\partial^4 z}{\partial x^4} - \omega^2 z = 0 \quad (10)$$

Letting:

$$q^4 = \frac{\omega^2}{A + i\omega B} \quad (11)$$

Then Eq 10 becomes:

$$\frac{d^4 z}{dx^4} + q^4 z = 0 \quad (12)$$

The solution of Eq 12 is standard and is:

$$Z = A'\cosh qx + B'\sinh qx + C'\cos qx + D'\sin qx \quad (13)$$

The constants in Eq 13 can be found by employing the proper boundary conditions. These are: at the clamped end the amplitude is $d_0 (y = d_0 e^{i\omega t})$

$$z = d_0 \qquad (x = 0) \quad (14)$$

At the clamped end:

$$\frac{dz}{dx} = 0 \qquad (x = 0) \quad (15)$$

At the free end since the reed is vertical the moment is 0:

$$M = \frac{d^2 z}{dx^2} = 0 \qquad (x = l) \quad (16)$$

At the free end the shearing force must equal the inertia force of the attached pin mass:

$$m_p\frac{\partial^2 y}{\partial t^2} = S\rho A\frac{\partial^2 y}{\partial x^3} + S\rho B\frac{\partial^4 y}{\partial x^3 \partial t} \quad (17)$$

Applying the above boundary conditions to Eq 13 one obtains five simultaneous algebraic equations. Using determinants to solve for the constants and substituting for them into Eq 13 results in:

Recalling Eq 11, for a purely elastic reed q becomes:

$$z|_e = d_0 \frac{[\cos ql + \cosh ql]}{[1 + \cos ql\cosh ql + q(m_p/\rho S)(\cos ql\sinh ql - \sin ql\cosh ql)]} \quad [18]$$

$$q = \frac{\omega^2}{A} \quad (19)$$

For a purely elastic reed at resonance the amplitude is infinite therefore at resonance:

$$z|_e = \infty \quad (20)$$

Thus the denominator of Eq 18 must be set to zero:

$$\left[1 + \cos ql\cosh ql + \frac{m_p}{\rho S}q(\cos ql\sinh ql - \sin ql\cosh ql)\right] = 0 \quad (21)$$

Solving Eq 21 for q by using series expansions results in:

$$q^4 = \frac{a_0^4}{l^4 + [(4m_p/\rho S)l^3]} = \frac{\omega_0^2}{A} \quad (22)$$

where: $a_0 = 1875$ (the root of $1 + \cos a \cosh a = 0$) and ω_0 = resonant frequency (fundamental).

For a pure elastic reed with no mass attached we know that:

$$\frac{\omega_0}{A} = \frac{a_0^4}{l^4} \quad (23)$$

Therefore the effect of the mass is to increase the length of the reed. Denoting l_e as:

$$l_e^4 = l^4 + \frac{4m_p}{\rho S}l^3 \quad (24)$$

we can then drop out the mass term in Eq 18 and substituting l_e for l Eq 18 becomes:

$$Z|_e = d_0\frac{\cos ql_e + \cosh ql_e}{1 + \cos ql_e\cosh ql_e} \quad (25)$$

Equation 25 is exactly the same as that obtained by Horio and Onogi (**4**) in their derivation of Equations for a viscoelastic reed except that l_e incorporates the effect of the mass of the pin.

One can proceed in the manner of Horio and Onogi (**3**) to obtain the following four equations:

$$|Z|_e|_{\max}{}^2 = \frac{a_0^2\{\sin^2 a_0 + 2b_0'[\cos a_0 - 3(1 - \cos a_0)\sin a_0/a_0]\}}{(b_0')^2(\cos a_0 - 1)^2} \quad (26)$$

$$b_0' = \frac{-\omega_0^{3/2}Bl_e}{4A^{5/4}} \quad (27)$$

$$\omega_0 = \frac{a_0^2 A^{1/2}}{l_e^2} \quad (28)$$

$$\omega_R = \omega_0\left[1 - \frac{1}{16}\left(\frac{B\omega_0}{A}\right)^2\right] \quad (29)$$

By algebra Eqs 26 to 29 can be solved for A and B

$$A = \left[\frac{16\omega_r l_e^2}{16a_0^2 - F^2}\right]^2 \quad (30)$$

$$B = \frac{Fl_e^2}{a_0^2}\left[\frac{16\omega_r l_e^2}{16a_0^2 - F^2}\right] \quad (31)$$

where:

$$F = \frac{-5.478 + 2\sqrt{7.502 + 6.15M^2}}{1.689M^2}$$

$$M^2 = |Z|_e|_{\max.}{}^2/d_0^2$$

Recalling that:

$$E' = 12\rho A/d^2 \quad (32)$$

$$\eta = 12\rho B/d^2 \quad (33)$$

and knowing that $E'' = \eta\omega$ then:

$$E'' = 12\rho\omega B/d^2 \quad (34)$$

substituting for A and B from Eqs 30 and 31 into Eqs 32 and 34 results in Eqs 1 and 2 for E' and E''.

Test Methods for Measuring Energy in a Gas Discharge

By S. I. Reynolds

The methods show that energy increases linearly with applied voltage, and that certain organic insulations placed in the discharge in a closed system with pure oxygen, degrade at a rate proportional to the measured power.

In order to study the degradation of insulating materials when subjected to high alternating voltages, two methods of test are usually used. In one method the solid dielectric in sheet form of a size large enough to prevent flashover is placed between two metal electrodes and the voltage is increased until surface ionization and sparking occurs at the edge of the high-potential electrode. The material is then usually left on test until failure by breakdown occurs. The other method is to place the dielectric in a corona discharge through a gas, terminated at both ends by an insulating layer of glass. This method lends itself to simpler interpretation because tests can be made in a closed system.

The power consumed in the glass corona generator can be measured by either of two methods using equipment that is available in most laboratories. Agreement between the two methods is shown to be within a few per cent. It is also found that the corona power increases linearly with voltage and that certain organic insulations when subjected to ionization in a closed system with pure oxygen degrade at a rate proportional to the measured power.

Methods for Measuring Corona Power

As shown by Dawes and Humphries,[1] a high-voltage impedance bridge can be used to measure power in a glass plate corona generator. As the bridge is operated to respond only to the fundamental frequency, in this case 60 cps, the power measured by the bridge corresponds to the fundamental voltage and current in the test specimen.

The parallelogram oscilloscope technique has been used by T. C. Manley[2] to measure the power in an ozonator discharge. The circuit diagram for this method is shown in Fig. 1. When ionization starts, a parallelogram is formed as shown in Fig. 2. The X-axis displacement is proportional to the voltage and the Y-axis displacement is proportional to the charge, q, in the system. By calibrating the scale divisions, by means of peak reading tube voltmeter, the peaks of voltage and charge are determined. One can then measure the area of the parallelogram to determine the power in watts.

The technique of area measurement is as follows: By means of a Poloroid Land camera the scope trace and an illuminated scope screen are photographed. The area $ABDE$ of the parallelogram (see Fig. 2) on the finished photographic print can then be measured accurately by means of a planimeter.

The bridge measurements for this work were made by means of a high-voltage Schering[3] bridge to determine the total capacity and loss angle of the corona generator below the ionization inception voltage.

Under these conditions the total losses are due to the glass, and when the voltage is raised to a value at which the

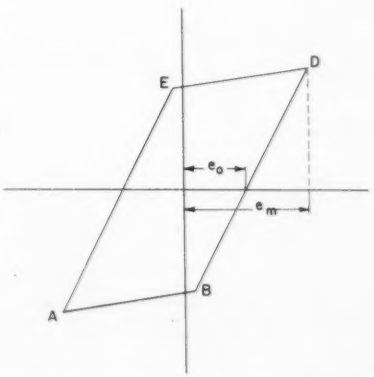

Fig. 2.—Power Diagram from Oscilloscope Trace.

Power dissipated per cycle = area = $4C_g e_o \left(e_m - \frac{C_a}{C} e_o\right)$

Maximum exterior charge = $Q = C_g (e_m - e_o)$

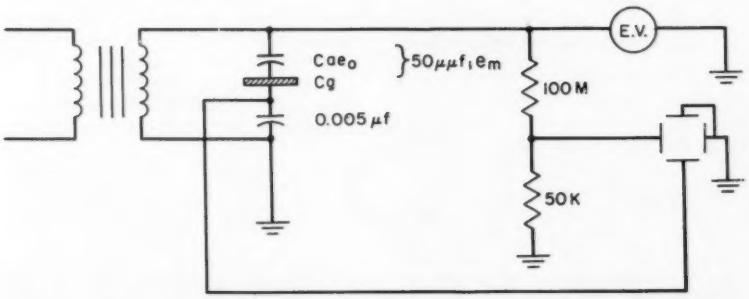

Fig. 1—Circuit Diagram of Oscillograph Connections for Corona Measurements.

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[1] C. L. Dawes and P. H. Humphries, "Characteristics of Restricted Ionization and Its Relation to Voids in Insulating Materials," Am. Inst. Electrical Engrs., *Transactions*, Vol. 59 (1940).

[2] T. C. Manley, "The Electric Characteristics of the Ozonator Discharge," *Transactions*, Electro Chemical Soc., Vol. 84, p. 82 (1943).

[3] B. Hague, "A. C. Bridge Methods," Sir Isaac Pitman and Sons, Ltd. London, Chapter IV, p. 352.

TABLE I.—WATTS MEASURED BY BRIDGE AND PARALLELOGRAM METHOD.

Kilovolt Peak	tan δ	C, $\mu\mu f$	G, mhos	Bridge Watts E^2G (E = rms)	Watts Parallelogram
5	0.0194	8.6	0.063×10^{-9}	0.0008	...
6	0.494	14.5	2.7×10^{-9}	0.048	0.040
7	0.478	19.5	3.5×10^{-9}	0.086	0.088
8	0.456	22.3	3.8×10^{-9}	0.122	0.102
9	0.399	24.2	3.6×10^{-9}	0.147	0.163
10	0.363	26.6	3.6×10^{-9}	0.182	0.202

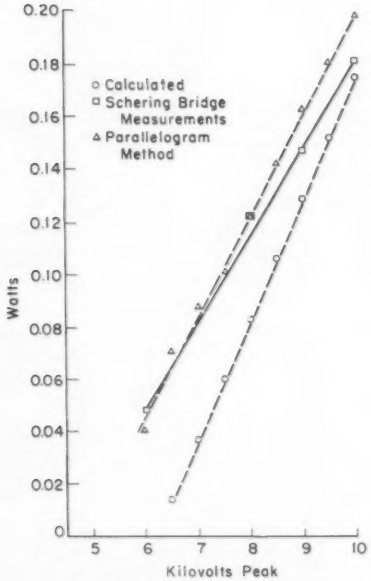

Fig. 3.—Power in Watts *Versus* Peak Kilovolts from Bridge and Parallelogram Methods.

ionization begins, the losses immediately increase due to the ionization current. The total capacity of the generator, the loss angle, and the frequency of the sine wave current can then be used to calculate the equivalent parallel conductance of the test cell by the formula $G = \tan \delta \omega C$. Once the conductance is determined as a function of voltage, above the ionization inception voltage, the power dissipated is calculated from the formula $W = E^2G$ where G is the total conductance across the test cell and E is the root mean square applied voltage.

A flat-plate corona test cell for comparison tests between bridge and parallelogram methods was made up as follows: Two lantern-slide-cover glasses $3\frac{1}{4}$ by 4 by 0.050 in. were separated by $\frac{1}{2}$ by 2 by 0.048 in. glass spacers placed at the outer edges of the plates and held in place by a suitable cement.

A $1\frac{1}{2}$ in. diameter guarded electrode was placed on one side of the generator opposite a 2-in. diameter electrode on the other. The total capacity, C, of the completed cell was measured to be 8.6 $\mu\mu f$. The exact capacity of the glass, C_g, was determined by measuring the glass separately using the same guarded electrodes to give a total capacity with two plates in series of 38.7 $\mu\mu f$. By calculation, the air-gap capacity, C_a, was then determined to be 9.9 $\mu\mu f$.

The corona cell was then set up with a glass tube so arranged that dry air could be blown through the generator in order to vent the air space properly.

Loss tangent and capacity measurements were then made using the high-voltage Schering bridge at 60 cps. Starting just below the corona onset voltage 5.2 kv peak, the measurements were made at 1-kv intervals up to 10 kv. The Schering bridge and parallelogram test results on this cell are shown in Table I.

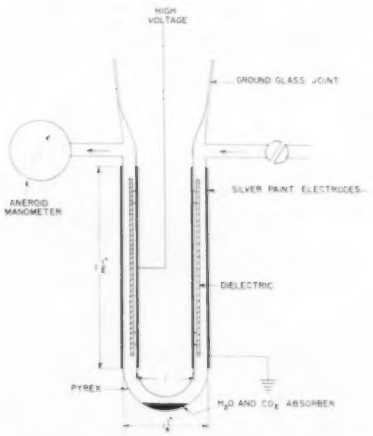

Fig. 4.—Schematic Diagram of Coaxial All-Glass Corona Generator.

The power in watts from the bridge measurements and from the parallelogram methods are also shown in Table I and in Fig. 3 as a function of applied peak voltage.

Manley[2] has shown that the power, W, dissipated in the air gap in series with a dielectric as shown in Fig. 1 can be calculated from the following equation:

$$W = 4f\, C_g e_s \left(e_m - \frac{C_a}{C} e_o \right)$$

where:

e_m = peak value of secondary voltage,
e_o = discharge potential across the gap,
C_a = capacity of air space alone,
C = total capacity where $\frac{1}{C} = \frac{1}{C_a} + \frac{1}{C_g}$, and
C_g = capacity of the glass dielectric.

If it is assumed that the spark potential of a gas between metal electrodes is the same as the sparking potential across the gap between dielectrics, the corona-starting voltage can be calculated if the air gap spacing is known and the series capacities, C_a and C_g, are determined by guarded bridge measurements.

The corona starting voltage

$$V_{cs} = \left(\frac{C_a}{C_g} + 1 \right) V_s$$

therefore, the power in watts is given by

$$W = 4f\, V_s C_g (V_o - V_{cs})$$

where:

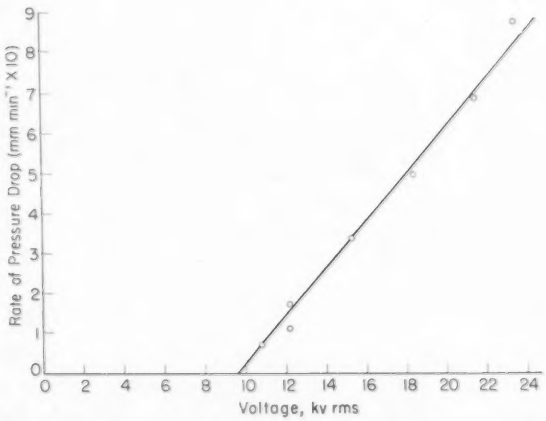

Fig. 5.—Corona Degradation of Polyethylene.

V_o = peak value of secondary voltage,
C_a = air gap capacity calculated,
C_g = dielectric capacity measured,
V_s = sparking potential for a given pressure and gap, and
V_{cs} = corona starting voltage, calculated peak value.

Using this formula, the power in watts for different peak voltages was calculated and plotted in Fig. 3. The difference in slope between the measured values obtained by bridge and parallelogram methods and the calculated values may indicate that the sparking potential between metal plates is not the same as between dielectrics. One factor is ionization persisting after the peak voltage is decreased below the starting potential.

Having established two suitable methods for measuring corona power, a study of insulation degradation in a corona generator system is in order.

John Devins of this laboratory used a coaxial corona generator as shown in Fig. 4 to measure the degradation of polyethylene in pure oxygen by placing drierite and ascarite in the bottom of the generator to absorb the CO_2 and H_2O formed by the induced reaction between polyethylene and oxygen under ionization conditions. An aneroid manometer was used to measure the decrease of oxygen pressure with time of voltage application for a given amount of power. In order to expose as much surface as possible to the discharge, the polyethylene was supported on polyethylene rings in such a way that the test sample was not in contact with the glass walls of the generator as shown in Fig. 4. He found that the rate of pressure drop was proportional to the applied voltage and therefore to the applied power as shown in Fig. 5.

Summary and Conclusion

Two methods for measuring corona power with equipment available in most laboratories have been described. These methods are found to agree with each other to the extent that semiquantitative measurements can be made to determine the degradation of some organic insulations.

It has been shown that the degradation of polyethylene occurs at a rate proportional to the power dissipated in the corona generator.

Effects of Corona on Plastic Laminates*

By A. Rufolo and R. R. Winans

A method of corona exposure and exposure effects on various properties of materials are presented as a basic approach to the problem of corona deterioration in electrical equipment.

Corona arc, as a source of many undesirable effects, is a constant problem to designers of electrical equipment. In many cases the designer has been able to eliminate corona. Where complete elimination of corona has not been feasible, the problem becomes a search for an engineering material whose performance is not influenced by corona. It is this phase of corona study, dealing specifically with the performance of engineering materials in a corona arc, which is the subject of this paper.

Corona attacks both metallic and nonmetallic components by physical, chemical, and thermal action. Its attack on the insulation components presents one of the more important factors influencing the service life of electrical machines and equipment. The modern trends toward miniaturization in electrical circuits, reduced sizes of equipment, and decreased spacing of parts have tended to increase the occurrence of corona. Hence, there has developed a considerable interest concerning information on the corona-resistance properties of insulating materials.

The investigation conducted by the Naval Material Laboratory, New York Naval Shipyard, has been confined to various types of plastic laminates. It was the aim of this study to determine the resistance of these materials to corona attack, as might be indicated by changes in certain of the electrical and mechanical properties after extended periods of exposure.

Procedure for Corona Exposure

The system of electrodes shown in Fig. 1 was devised to permit corona exposure of five specimens simultaneously. The electrodes were brass cylinders 2 in. in diameter, $\frac{1}{2}$ in. in length, and with contact edges rounded to a $\frac{1}{4}$-in. radius. These are an ASTM D 149–44 standard-type electrode for dielectric strength measurements. The electrodes were attached to $\frac{1}{4}$-in. diameter brass shafts and mounted in vertical bushings to provide adjustment of the air gap on either side of the specimen between electrode pairs. The specimens were supported independently of the electrodes by plastic supports fixed to the sides of the compartments in the holding frame. Throughout the investigation a constant air gap of 0.030 in. was maintained between the specimen and each electrode. In this way the corona arc impinged on the top and bottom surfaces of the specimen over areas approximately 2 in. in diameter.

A potential of 8000 v at 60 cycles was selected as suitable to provide a corona

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* The opinions or assertions contained herein are those of the authors and are not to be construed as reflecting the views of the Navy Department or the Naval Service at large.

The Authors . . .

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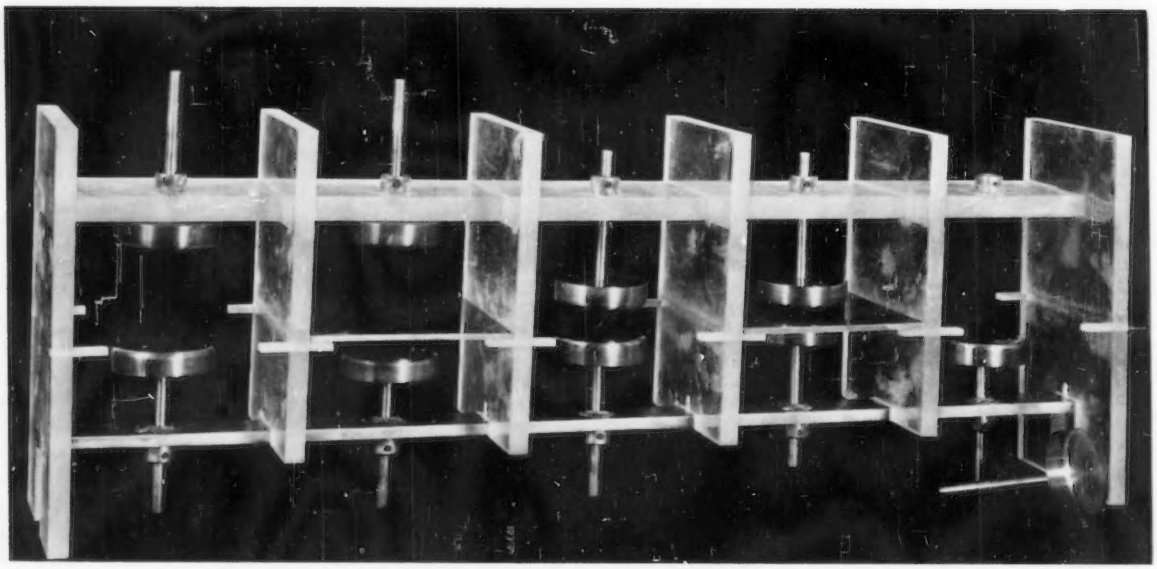

Fig. 1.—Apparatus for Corona Exposure.

are well beyond the audible and visible range with any of the materials under study. In addition, this voltage was considered to constitute a suitably accelerated exposure condition. The voltage was continuously applied to all specimens except for those short intervals when specimens were removed for the periodic evaluations discussed below.

Materials Investigated

The materials investigated were the more common laminates covered by Joint Military Specifications and two glass-reinforced Teflon laminates. These materials, and their corresponding type or code designation, were as follows:

1.	Paper-base	Phenolic PBE
2.	Fabric-reinforced	Phenolic FBG
3.	Glass-reinforced	Melamine GMG
4.	Glass-reinforced	Silicone GSG
5.	Glass-reinforced Teflon	Manufacturer A TeG1
6.	Glass-reinforced Teflon	Manufacturer B TeG2

The specimens used were 4-in. squares cut from 3 by 4 ft by $\frac{1}{8}$-in. panels and selected at random.

Investigation of Corona Effects

Several electrical and mechanical properties of the laminates were used to evaluate the effects of corona exposure. The properties were:

Power factor, 1000 cps
Dielectric constant, 1000 cps
Volume resistivity
Surface resistivity
Dielectric breakdown (step-by-step)
Tensile strength
Flexural strength
Flexural modulus

These properties were determined for all materials prior to the start of corona exposure. Specimens were then placed in the 8000-v arc for a long-term exposure which was continuous except for the interruptions when periodic measurements were made. It will be noted that the first four of these properties involved nondestructive tests, whereas the last four were properties which could not be determined without destroying the specimens. Consequently, initial periodic and final measurements of a nondestructive nature were made on the same specimens. Where "destructive" determinations were involved, initial measurements were made on a separate group of specimens; periodic measurements were eliminated entirely; and final measurements were made on the same specimens used for the nondestructive tests, but only after all other measurements on them had been completed. All evaluations were averages of five individual measurements on five specimens.

All of the materials in this investigation were exposed to corona at 25 C and 50 per cent relative humidity. The GSG, TeG1, and TeG2 materials were, in addition, exposed to a corona at 25 C and 96 per cent relative humidity, and, in order to maintain a control, other specimens of these three materials were exposed concurrently to a 25 C and 96 per cent relative humidity condition without corona.

Results of the Investigation

The results of this study have been tabulated according to the various laminates investigated. To facilitate the tabulation, a number of common abbreviations were used as follows:

Exposure Conditions:

Cor/25 C/50% RH—corona exposure at 25 C and 50 per cent relative humidity.
Cor/25 C/96% RH—corona exposure at 25 C and 96 per cent relative humidity.
C/25 C/96% RH—exposure without corona at 25 C and 96 per cent relative humidity.

Physical Properties:

Pf—power factor at 1000 cps.
Dk—dielectric constant at 1000 cps.
Rv—volume resistivity, 10^6 megohms per cm.
Rs—surface resistivity, 10^6 megohms.
V—dielectric strength, volts per mil.
S_t—tensile strength, psi
S_f—flexural strength, psi
E_f—flexural modulus, 10^6 psi

Resistivities were reported as "greater than 600" when this property exceeded the maximum value measurable with the megohm bridge. In determining dielectric strength, dielectric strengths of "greater than" a designated value were reported when breakdowns were the result of arcing around rather than through the specimen, and these designated values were the voltage stresses at which flashover occurred.

Since exposed specimens were 4 by 4 by $\frac{1}{8}$ in., it was necessary to conduct mechanical tests on specimens of re-

TABLE I.—PAPER-BASE PHENOLIC (PBE).

Hours at Cor/25 C/50% RH	0	100	500	1100
Physical properties:				
Pf	0.0323	0.0349	0.0336	0.030
Dk	5.5	5.5	5.5	5.6
Rv	7.6	4.8	3.9	2.6
Rs	2.70	3.3	5.6	2.9
V	540	...	...	540
St	12 200	...	...	14 200
Sf	20 900	...	...	20 200
Ef	1.29	...	...	1.29

TABLE II.—FABRIC-REINFORCED PHENOLIC (FBG).

Hours at Cor/25 C/50% RH	0	100	500	1100	1500
Physical properties:					
Pf	0.206	0.204	0.168	0.163	0.171
Dk	6.8	6.5	7.3	7.1	7.4
Rv	0.16	0.17	0.16	0.19	0.18
Rs	0.10	0.003	0.04	0.07	0.03
V	250	...	...	...	140
St	8 810	...	...	...	8 470
Sf	18 900	...	...	...	15 100
Ef	...	...	...	...	...

TABLE III.—GLASS-REINFORCED MELAMINE (GMG).

Hours at Cor/25 C/50% RH	0	500	1100
Physical properties:			
Pf	0.0383	0.0430	0.0288
Dk	7.4	7.3	7.2
Rv	2.7	2.0	3.0
Rs	0.4	0.9	0.5
V	440	...	230
St	32 600	...	33 100
Sf	48 700	...	36 900
Ef	...	...	...

TABLE IV.—GLASS-REINFORCED SILICONE (GSG).

Physical Property	Exposure Condition	Exposed 0 hr	Exposed 100 hr	Exposed 500 hr	Exposed 1100 hr
Pf	Cor/25 C/50% RH	0.0092	0.0122	0.0133	0.0114
	Cor/25 C/96% RH	0.0110	0.270	0.83	...
	C/25 C/96% RH	0.0094	0.110	0.115	...
Dk	Cor/25 C/50% RH	3.7	3.8	3.8	3.8
	Cor/25 C/96% RH	3.7	6.6	16.3	...
	C/25 C/96% RH	3.7	5.6	6.5	...
Rv	Cor/25 C/50% RH	>600	>600	120	40
	Cor/25 C/96% RH	1.0	0.2	0.01	...
	C/25 C/96% RH	3.0	1.0	0.30	...
Rs	Cor/25 C/50% RH	2.7	1.6	2.6	0.3
	Cor/25 C/96% RH	0.7	0.001	0.00001	...
	C/25 C/96% RH	0.6	0.16	0.01	...
V	Cor/25 C/50% RH	410	...	...	340
	Cor/25 C/96% RH	410	...	230	...
	C/25 C/96% RH	410	...	270	...
St	Cor/25 C/50% RH	23 700	...	...	22 800
	Cor/25 C/96% RH	23 700	...	27 200	...
	C/25 C/96% RH	23 700	...	26 700	...
Sf	Cor/25 C/50% RH	35 600	...	...	27 800
	Cor/25 C/96% RH	35 600	...	28 700	...
	C/25 C/96% RH	35 600	...	31 900	...
Ef	Cor/25 C/50% RH	1.95	...	...	1.81
	Cor/25 C/96% RH	1.95	...	2.07	...
	C/25 C/96% RH	1.95	...	2.09	...

duced size. All tensile specimens were $\frac{3}{4}$ by 4 by $\frac{1}{8}$ in. with a $\frac{1}{2}$-in. necked down width for a 2-in. length at the middle. All flexure specimens were $\frac{1}{2}$ by 4 by $\frac{1}{8}$ in.

Conclusions

It became evident from an examination of the data that two factors should be considered for a proper evaluation. The first concerns the mode of sampling which permitted certain properties to be determined on the same specimen throughout an exposure, whereas other properties had to be determined on different specimens before and after exposure. The second is the variability of individual measurements which, for lack of a good control, is frequently accepted as an inherent quality of certain properties. Properties like surface and volume resistivities, and dielectric strength to a much lesser degree, are often quite variable, whereas electrical loss factors and mechanical properties are usually much more uniform from specimen to specimen of a given material. The conclusions that follow were influenced to an extent by these considerations.

A close inspection of the data on the PBE laminate (Table I) indicated no significant changes. The changes in surface and volume resistivities were too small to warrant concern, despite the apparent steady trend. The change in tensile strength could have been a specimen-to-specimen variation.

The data on the FBG laminate, given in Table II, provided more definite evidences of the effects of corona. The decreases in dielectric strength and flexural strength were appreciable in view of the normally stable characteristics of these properties. The variations in power factor and dielectric constant were further evidence that the corona exposure had produced some internal changes in the laminate.

The behavior of the GMG laminate, noted in Table III, was almost identical with that of the FBG laminate. Dielectric strength and flexural strength again were the indicators of some internal change with some support provided by the erratic power factor data.

Most of the changes in properties noted for the GSG laminate (Table IV) after condition Cor/25 C/50% RH could not be considered significant individually. However, variations in so many of the properties did seem to indicate that significant changes had occurred. The results after a relatively short exposure period at condition Cor/25 C/96% RH left no doubt that the combination of humidity and corona are seriously reduced the electrical insulating properties. A comparison with the effects after conditions Cor/25 C/50% RH and C/25 C/96% RH showed further that the presence of corona had been the chief cause for this severe deterioration. The irregular behavior of the mechanical properties could not be explained, although flexural strength did show consistently the effects of both corona exposures.

The glass-reinforced Teflon laminates (Tables V and VI) were somewhat similar in behavior, with the TeG1 showing a slightly greater susceptibility to the effects of corona. The effects of corona at high humidity again were sharply distinguishable from the separate effects of either corona or humidity with the difference that, unlike the GSG laminate, the effects were much more pronounced for the mechanical properties and less severe for the electrical characteristics.

TABLE V.—GLASS-REINFORCED TEFLON (TeG1).

Physical Properties	Exposure Condition	Exposed 0 hr	Exposed 100 hr	Exposed 500 hr	Exposed 1100 hr	Exposed 1500 hr
Pf	Cor/25 C/50% RH	0.0106	0.0107	0.0087	0.0068	...
	Cor/25 C/96% RH	0.0710	0.094	0.121	0.162	0.24
	C/25 C/96% RH	0.0390	0.058	0.129	0.140	0.132
Dk	Cor/25 C/50% RH	2.5	2.6	2.5	2.5	...
	Cor/25 C/96% RH	2.9	3.1	3.3	3.6	5.0
	C/25 C/96% RH	2.7	2.9	3.3	3.3	3.5
Rv	Cor/25 C/50% RH	50	>600	100	200	...
	Cor/25 C/96% RH	90	110	0.05	0.001	0.005
	C/25 C/96% RH	110	>600	12	6.0	7.0
Rs	Cor/25 C/50% RH	23	11	70	50	...
	Cor/25 C/96% RH	45	136	0.007	0.0004	0.0002
	C/25 C/96% RH	45	120	11	3.1	3.5
V	Cor/25 C/50% RH	>570	...	...	>570	...
	Cor/25 C/96% RH	>570	...	...	...	230
	C/25 C/96% RH	>570	...	...	...	>400
St	Cor/25 C/50% RH	11 200	...	...	11 100	...
	Cor/25 C/96% RH	11 200	...	...	...	10 300
	C/25 C/96% RH	11 200	...	...	...	10 300
Sf	Cor/25 C/50% RH	10 600	...	...	8 670	...
	Cor/25 C/96% RH	10 600	...	...	...	9 450
	C/25 C/96% RH	10 600	...	...	...	10 300
Ef	Cor/25 C/50% RH	1.14	...	...	...	...
	Cor/25 C/96% RH	1.14	...	...	...	0.88
	C/25 C/96% RH	1.14	...	...	...	0.98

TABLE VI.—GLASS-REINFORCED TEFLON (TeG2).

Physical Properties	Exposure Condition	Exposed 0 hr	Exposed 100 hr	Exposed 500 hr	Exposed 1100 hr	Exposed 1500 hr
Pf	Cor/25 C/50% RH	0.0017	0.0014	0.0024	0.0023	0.0022
	Cor/25 C/96% RH	0.0105	0.0173	0.102	0.398	...
	C/25 C/96% RH	0.0123	0.038	0.124	0.128	...
Dk	Cor/25 C/50% RH	2.7	2.7	2.7	2.7	2.5
	Cor/25 C/96% RH	2.6	2.6	5.1	7.9	...
	C/25 C/96% RH	2.6	2.6	3.8	3.9	...
Rv	Cor/25 C/50% RH	160	190	20	15	170
	Cor/25 C/96% RH	14	40	11	0.09	...
	C/25 C/96% RH	36	83	120	38	...
Rs	Cor/25 C/50% RH	70	150	0.7	1.2	0.9
	Cor/25 C/96% RH	14	42	11	0.09	...
	C/25 C/96% RH	14	73	280	17	...
V	Cor/25 C/50% RH	>390	...	...	...	240
	Cor/25 C/96% RH	>390	...	...	30	...
	C/25 C/96% RH	>390	...	...	240	...
St	Cor/25 C/50% RH	16 900	...	...	...	16 800
	Cor/25 C/96% RH	16 900	...	...	5 000	...
	C/25 C/96% RH	16 900	...	...	11 300	...
Sf	Cor/25 C/50% RH	12 600	...	...	...	10 700
	Cor/25 C/96% RH	12 600	...	...	1 300	...
	C/25 C/96% RH	12 600	...	...	6 900	...
Ef	Cor/25 C/50% RH	1.07	...	...	...	0.85
	Cor/25 C/96% RH	1.07	...	...	0.22	...
	C/25 C/96% RH	1.07	...	...	0.78	...

Discussion

Several general observations seemed justifiable on the results of this study. It was apparent that several of the properties, such as the electrical resistivities were highly variable and, in a short-term corona exposure, could not be expected to give significant indications of material deterioration. In exposures under moderately accelerated conditions, all of the properties would be suitable indicators and could be expected to show differences among laminates. It was evident that dielectric strength and flexural strength were the properties most susceptible to degradation after corona exposures. This selectivity is not at the moment explainable except that both indicated internal changes that were not detectable by other measurements.

The results were sufficiently illuminating to warrant further investigation. It was evident that corona at 96 per cent relative humidity was an accelerated condition and that studies at some humidity intermediate between 50 per cent and 96 per cent would be useful for further evaluation of the laminates. Another plausible channel of investigation should be the effects of corona at elevated temperatures. It is possible that such an investigation would enable a synthesis of corona exposure into electrical and thermal effects.

It is hoped that this limited investigation of a broad subject has succeeded in giving a glimpse of the quantitative changes in the characteristics of materials exposed to corona and that it will stimulate interest along some indicated avenues of further investigation.

Acknowledgment:

This project was sponsored by the Bureau of Ships which authorized the work at the Material Laboratory. The article was prepared at the request of the Bureau of Ships, indicating that a technical paper on the Naval Material Laboratory's program dealing with the effects of corona on laminates would be of interest.

Discussion of Paper on Some Volume Changes in Mortars and Concrete[1]

MR. MORTON SHERMAN.[2]—It is well known that when the fines content of a concrete mix increases, the amount of water required to attain proper workability and consistency will also increase (excluding the effects of air entrainment). This is merely the effect caused by the presence of additional aggregate surface requiring a lubricating film of liquid.

It is also conceivable that the characteristics of the cementitious phase which cause compressive strength to decrease as water-cement ratio increases, are the same characteristics which allow shrinkage movement to occur.

I believe this additional water is the primary reason for the correlation found between the percentage of fines and the resultant shrinkage. The fine aggregate promoted shrinkage only in that it increased the amount of water required to achieve working consistency. Control of the fines content would be effective only in that the quantity of water needed for the proper consistency would then be held at a minimum.

MR. ANDEREGG (*authors' closure*).—We are glad Mr. Sherman has emphasized the role played by fine aggregate in increasing water requirement to secure a workable mortar and has brought out the effect of such an increase on shrinkage.

[1] F. O. Anderegg and J. A. Anderegg, "Some Volume Changes in Mortars and Concrete," ASTM BULLETIN, No. 210, December, 1956, p. 60 (*TP236*).

[2] Chemical engineer, Zonolite Co., Evanston, Ill.

All-Glass Multiple-Test Apparatus for Corrosion Testing of Stainless Steels

By J. V. Alger, E. C. Roberts, R. P. Lent, and G. W. Anderton

An all-glass multiple-test apparatus for evaluating susceptibility to intergranular corrosion and the corrosion resistance of stainless steels in boiling 65 per cent nitric acid. The results obtained closely correspond to those resulting from the ASTM Recommended Practice A 262[1] or Huey Test.

THE MOST frequently used method for testing the susceptibility to intergranular corrosion of stainless steels is the so-called "Huey Test" described in ASTM Recommended Practice A262.[1] This method consists of exposing a prepared specimen of the steel being tested to boiling 65 per cent nitric acid for a total time of 240 hr. The specimen is removed from the acid, washed, dried, and weighed after each 48 hr interval, and the amount of attack that has occurred is computed by use of the formula:

$$R = \frac{KW}{AST}$$

where:

R = rate of corrosion in inches of penetration per month (IPM),
K = constant (equal to 43.9 if A is in square inches),
W = weight loss in grams,
A = total surface area in square inches,
S = density of the sample in grams per cubic centimeter, and
T = duration of the test period, hr.

At the end of each 48-hr period the initial acid is replaced by fresh HNO_3 to prevent the acceleration of the rate of attack by the corrosion products of the previous 48-hr exposure period. The main offensive product in this respect has been shown to be hexavalent chromium ion, which after reaching a concentration in the neighborhood of 30 ppm (parts by weight per million) causes the corrosion rate to accelerate exponentially.[2]

It should be pointed out that it is the opinion of Brown, *et al.*,[3] that values obtained by the Huey Test can serve only as a qualitative indication of the

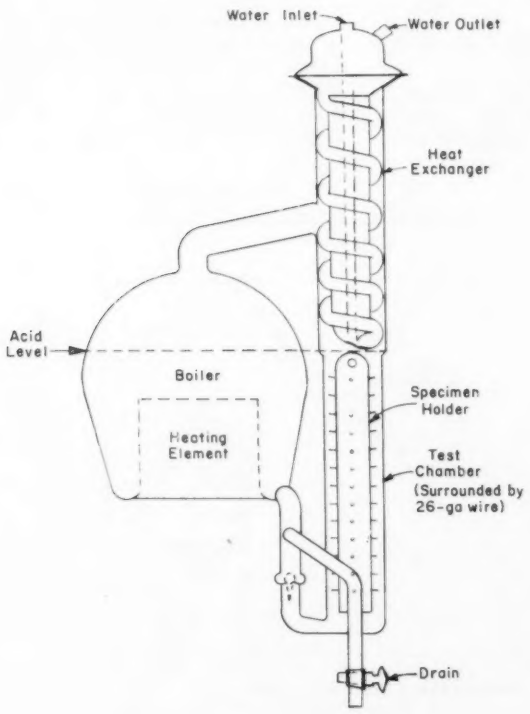

Fig. 1.—All-Glass Multiple Testing Apparatus.

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[1] Boiling Nitric Acid Test for Corrosion-Resisting Steels (A 262 – 55 T) 1955 Book of ASTM Standards, Part 1, p. 1108.

[2] W. B. DeLong "Testing Multiple Specimens of Stainless Steels in a Modified Boiling Nitric Acid Test Apparatus," Symposium on Evaluating Tests for Stainless Steels, Am. Soc. Testing Mats., p. 211 (1949). (Issued as separate publication *ASTM STP No. 93.*)

[3] M. H. Brown, W. B. DeLong, and W. R. Myers, *ibid*, p. 103.

The Authors . . .

JAMES V. ALGER, Atomic Power Div., Westinghouse Electric Co., Pittsburgh, Pa., was directing the corrosion testing activities of the Technical Research Co., Seattle, Wash., and graduate student in the Division of Metallurgical Engineering at the University of Washington, when the work described in this paper was done.

EARL C. ROBERTS, associate professor of metallurgical engineering, University of Washington, Seattle, has been working in the metallurgical research and teaching fields since 1943.

R. P. LENT, professional engineer, Technical Research Co., Seattle, is engaged in corrosion testing of metals and applied research in polymers and their use as corrosion protection of metals under submerged conditions.

G. W. ANDERTON, chemical research engineer, Boeing Airplane Co., Seattle, since 1948, has been primarily engaged in work on corrosion of metals.

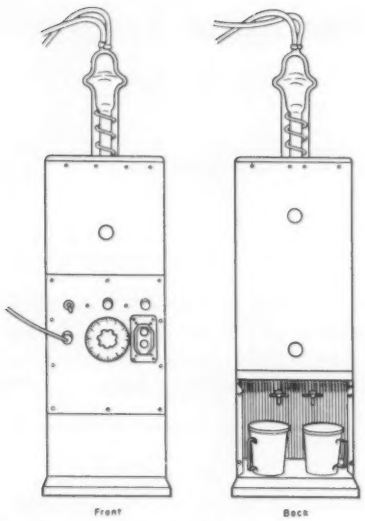

Fig. 2.—All-Glass Multiple Testing Apparatus.

corrosion behavior of the material in other acid environment. However, it does result in a more quantitative evaluation of the degree of susceptibility to intergranular corrosion in 65 per cent nitric acid than simply a "good," "medium," or "bad" classification.

Apparatus

The apparatus used in this investigation is illustrated in Figs. 1 and 2.

Essentially, this apparatus consists of a boiler from which nitric acid is distilled into the top of a test chamber. A return line from the bottom of the test chamber feeds the acid and any dissolved material back into the boiler by gravity flow. Construction is entirely of glass with the incorporation of such features as expansion bellows and a glass check valve to prevent any acid from flowing from the boiler into the test chamber via the feedback line.

Only slightly more than one liter of acid is required to charge the apparatus and, since the entire unit is thermally insulated with vermiculite, approximately 1000 w suffices both to operate the boiler and to keep the test chamber acid boiling by means of a differentially wound heating element. It is light in weight (approximately 60 lb) and can be accommodated by any laboratory that has a water supply and a 110 v a-c electrical outlet. As many as 60 specimens can be tested simultaneously. They are held in the unit on glass projections from a weighted Teflon rod. The angle of the projections is such that the test specimens are held away from the surface of the rod and thus uniform contact with the acid is assured.

Evaluation of the Apparatus

In order to determine the efficacy of the apparatus it was deemed appropriate to determine the corrosion rates of specimens of identical origins in the corroding environment according to the ASTM Recommended Practice A 262[1] and when the same corroding environment was contained in the subject apparatus.

To this end specimens representing stainless steel types 304L, 308L, 309SCB, and 347 were selected for the initial tests. Eight specimens, as nearly the same size and shape as possible, were cut from each of ten heats. By random choice, four of the specimens from each heat were selected to be exposed singly in flasks; the other four specimens from each heat were tested in the subject apparatus. All specimens were prepared as recommended for research work in A 262. The specimens exposed singly in flasks were each immersed in sufficient acid to provide 250 ml per sq in. of specimen surface. Double the recommended quantity[1] of acid was used to assure that the maximum hexavalent chromium ion concentration would not exceed a few parts per million. The acid was replaced after each 48-hr boiling period. Random placement of the samples in the flasks and in the multiple testing apparatus was maintained in all exposure periods.

All of the nitric acid used in the testing program was taken from the same source so that the strength at the start of each period was the same for all tests. The results are tabulated in Table I and shown graphically in Fig. 3.

TABLE I.—COMPARISON OF MULTI-SAMPLE CORROSION TEST RATES WITH STANDARD NITRIC ACID CORROSION TEST RATES FOR DIFFERENT STAINLESS ALLOYS.

Heat	Type	Over-all Average Rates,[a] ipm	
		Exposed Singly in Flasks	Exposed in All-Glass Multiple Tester
A	304L	90×10^{-5}	100×10^{-5}
B	304L	90	90
C	309SCB	53	51
D	309SCB	45	48
E	347	87	85
F	347	96	85
G	304L	193	194
H	304L	109	102
I	308L	103	109
J	308L	93	84

[a] Sum of average rates for four specimens divided by 4.

The second series of tests was conducted on 304L material that was known to have a high degree of susceptibility to intergranular corrosion. Duplicate specimens from samples of 20 different heats were prepared as before and exposed to acid by both methods. However, in this series, the acid in the flasks was changed every 12 hr to minimize the corrosion product effect.

A specimen from a single bar of previously evaluated material was included in the apparatus to serve as a control. This control varied not more than 2 per cent from the previously determined corrosion rate. The results are shown in Table II and Fig. 4.

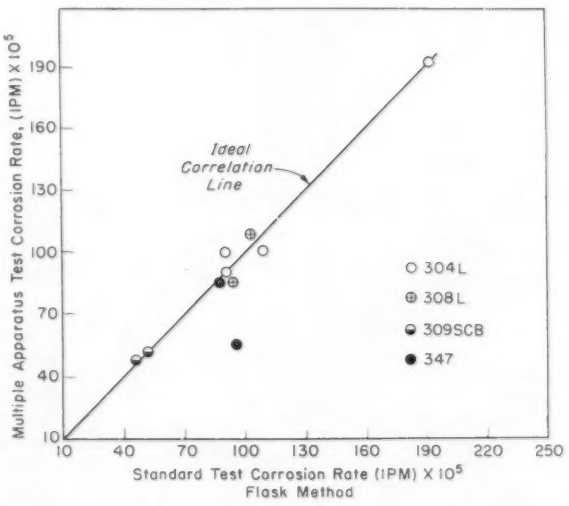

Fig. 3.—Comparison of Multi-Sample and Standard Nitric Acid Test Corrosion Rates.

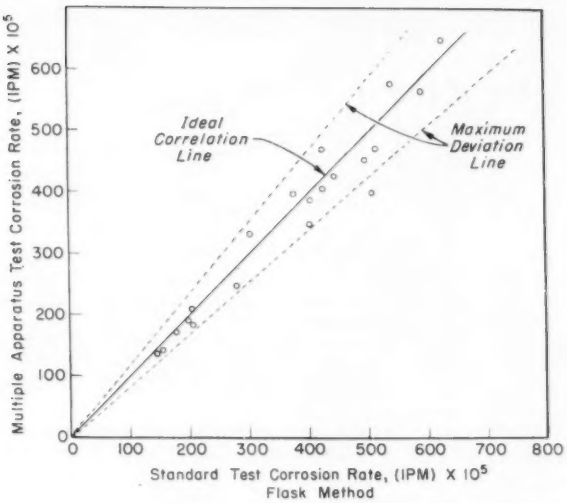
Multiple Apparatus Test Corrosion Rate, (IPM) X 10⁵
Ideal Correlation Line
Maximum Deviation Line
Standard Test Corrosion Rate, (IPM) X 10⁵ Flask Method

Fig. 4.—Comparison of Multi-Sample and Standard Nitric Acid Test Corrosion Rates for Higher Rate Specimens.

TABLE II.—COMPARISON OF MULTI-SAMPLE CORROSION TEST RATES WITH STANDARD NITRIC ACID CORROSION TEST RATES FOR HIGHER RATE SAMPLES.

Single Flask Results, ipm	All Glass Multiple Results, ipm
442 × 10⁻⁵	428 × 10⁻⁵
399	388
513	476
622	654
196	193
156	148
148	144
205	189
179	176
203	211
300	342
278	250
400	350
372	401
410	422
422	473
495	355
505	402
537	585
588	569

In order to determine the rate at which the test chamber was evacuated of corrosion products while boiling normally, 100 ppm of chromium ion was added to the acid in the apparatus. The solution was then brought to a normal boil and samples of the acid were taken at 5-min intervals for 30 min and at 10-min intervals for the next 100 min. These samples were analyzed with a Beckman flame photometer. The results are shown in the graph in Fig. 5.

The final series of tests were made on samples from two different heats of 304L material. Sixteen samples were taken from one heat and 14 from the second heat. From each of the samples, two Huey specimens were prepared. One specimen from each sample was exposed to the acid in a flask and the other exposed in the subject apparatus. On the second and fourth exposure periods for the specimens exposed in the subject apparatus, 100 ppm of chromium ion was deliberately added to the acid. The resulting solution was then allowed to boil for 30 min before the specimens were exposed to it. Inasmuch as there was no detectable change in corrosion rate indicated by this test, it can be concluded that the deleterious chromium ion had essentially been eliminated before the commencement of testing. The results of these tests are shown in Table III and Fig. 6.

The same material used in this final series of tests was tested at the laboratory of the Lukens Steel Co. Their samples were cut adjacent to those tested here. From each of their samples, two specimens were prepared, one for exposure in a flask with a 130 ml per sq in. acid ratio and the other for exposure in a du Pont Multi-sample Tester. The results of their tests are shown in Table III and Fig. 7. A graph of their flask results and the results obtained with the flasks in this laboratory is shown in Fig. 8.

Discussion

While the over-all picture does not show a strictly linear correspondence between the multiple and single flask methods of testing (Fig. 6), the deviations are apparently less than those encountered in separately determined flask methods on a particular set of specimens (Fig. 8). Figure 2 shows that, except for one point, the maximum deviation lines enclose a con-

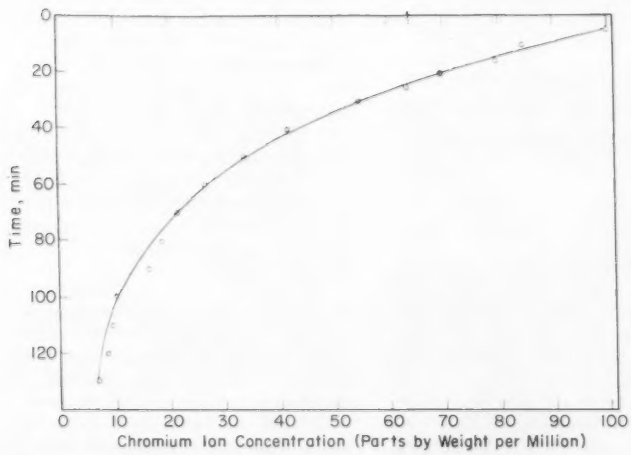

Fig. 5.—Chromium Concentration *versus* Time for Normal Boiling of Multiple Test Apparatus.

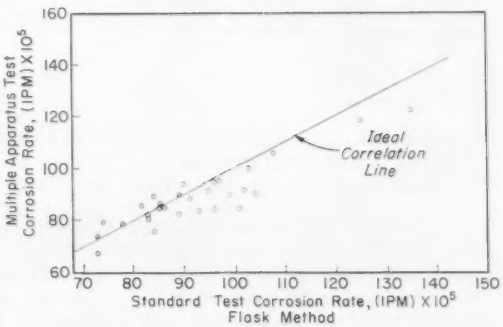
Multiple Apparatus Test Corrosion Rate, (IPM) X 10⁵
Ideal Correlation Line
Standard Test Corrosion Rate, (IPM) X 10⁵ Flask Method

Fig. 6.—Comparison of Multi-Sample and Standard Nitric Acid Test Corrosion Rates.

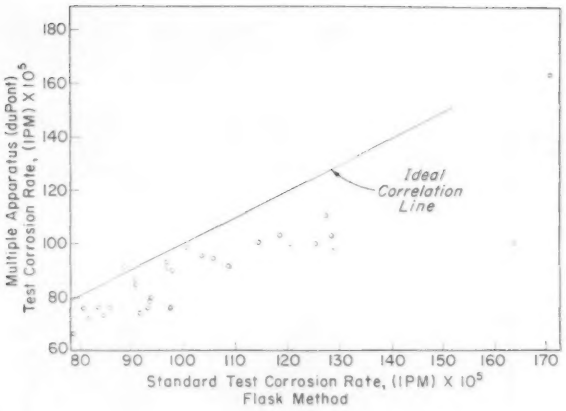

Fig. 7.—Comparison of Multi-Sample (du Pont Apparatus) and Standard Nitric Acid Test Corrosion Rates (by Lukens Steel Co.).

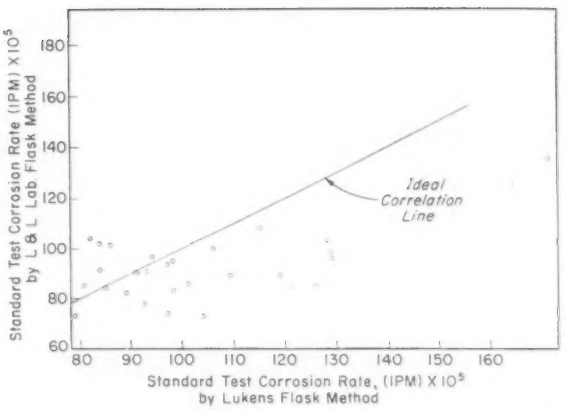
Standard Test Corrosion Rate (IPM) X 10^5 by L & L Lab Flask Method
180
160
140
120
100
80
60
Ideal Correlation Line
80 90 100 110 120 130 140 150 160
Standard Test Corrosion Rate, (IPM) X 10^5 by Lukens Flask Method

Fig. 8.—Comparison of Standard Nitric Acid Corrosion Rates as Determined by Two Separate Laboratories.

TABLE III.—BOILING NITRIC ACID COMPARISON TEST RESULTS.

Heat	Series 1[a] Multiple Flask, ipm		Series 2[b] Multiple Flask, ipm	
A.....	92 × 10^{-5}	109 × 10^{-5}	89 × 10^{-5}	89 × 10^{-5}
	93	97	79	74
	76	86	84	101
	79	94	95	97
	73	85	81	83
	92	89	85	82
	76	93	88	91
	72	82	90	104
	76	84	91	102
	87	91	89	84
	76	81	84	85
	91	97	83	93
	165	171	122	135
	79	94	84	96
	95	106	99	100
	85	91	94	90
B.....	101	164	118	125
	98	129	94	96
	112	128	100	103
	74	92	78	78
	76	98	80	83
	90	98	91	95
	99	121	75	84
	99	101	84	86
	101	126	86	85
	101	115	105	108
	104	119	82	89
	104	129	89	99
	66	79	73	73
	96	104	67	73

[a] All tests in this series carried out at the Lukens Steel Co. A du Pont Multi-Sample Tester was used in comparison with the regular t ask test.

[b] Results from the all-glass multiple tester and simultaneous flask comparison tests performed during this investigation.

siderably narrower zone than that shown by DeLong in the evaluation of the du Pont Multi-sample Tester.[2] Since the tests were quite comprehensive and done completely independently, it is felt that the advantages of the all-glass multiple test apparatus are obvious.

It is interesting to note that in DeLong's work,[4] 155 ml per sq in. was used for the single flask determinations, and his results indicated that the multiple apparatus gave average rates approximately 20 per cent less than when the specimens were exposed singly in flasks. In Lukens' work the ratio was 130 ml per sq in., and the values obtained, when compared to those obtained in the du Pont Multi-sample Tester, are somewhat lower than the ideal correlation line (Fig. 7).

[4] W. B. DeLong, *ibid.*, Am. Soc. Testing Mats., p. 213.

The flask determinations used in the all-glass multiple apparatus testing program were conducted with a ratio of 250 ml per sq in., and there seems to be good agreement between single and multiple test methods.

Conclusions

On the basis of the work herein reported it appears that the minimum acid ratio of 125 ml per sq in. as set by ASTM Recommended Practice A 262[1] is too low.

By virtue of its ability to remove the corrosion products as they are formed, the subject apparatus gives results in good agreement with those obtained by testing the same material singly in flasks where a large enough acid volume to specimen surface area ratio is used to dilute the corrosion products to a harmless concentration.

The all-glass multiple test apparatus appears to be very capable of fulfilling a role in the field of quality control of corrosion-resistant steels and therefore seems a logical successor to the more cumbersome single flask method. It also seems to offer special advantages over previously constructed multiple testers among which are: convenience of operation, adaptability, and lowered construction cost.

Acknowledgment:

The multiple test apparatus used in this investigation was designed and constructed through the cooperative efforts of the Lambert & Lent Laboratories of Seattle, Wash., and the Precision Research Products Co. of Corvallis, Ore.

We wish to thank the Lukens Steel Co. and the General Electric Co. for permission to publish the data shown in Table III, series 1.

A New Atmospheric Cycling Test for Corrosion Study

By T. J. Nussdorfer and D. O. White

Apparatus designed to simulate the daily cycling of atmospheric conditions was used to evaluate volatile corrosion inhibitors and preservative oils in reciprocating and turbojet engines. Qualitative correlation of laboratory with field results was demonstrated.

THE corrosion problem encountered by the Navy Department, Bureau of Aeronautics, in the shipment and storage of aircraft engines during and immediately following World War II prompted an investigation of volatile corrosion-inhibitor (VCI) materials, because of the simplified procedures of application and depreservation. Arthur D. Little, Inc., was engaged to evaluate commercially available VCI materials for the preservation of reciprocating engines. In the early stages of this study, it became apparent (1)[1] that standard commercial test equipment (2,3) such as the humidity cabinet (4) or salt-spray cabinet[2] was not suited for such a purpose, because of the washing action of condensing moisture and insufficient control of the circulating air. These shortcomings led to the development of a new test procedure which reproduced, on an accelerated-time basis, the pattern of corrosion-inducing conditions expected in the field—the daily cycle of atmospheric conditions from nightly condensation to daily evaporation of moisture.

Subsequent to the work on reciprocating engines, this apparatus was modified for use in a similar program on the preservation of turbo-jet engines. For both programs, the corrosion-inducing conditions were identical, but the engine components and VCI materials were different. Protection of reciprocating engines involved ferrous cylinder assemblies, while that of jet engines included the magnesium, aluminum, and stainless-steel components present in the compressor section of some axial-flow engines.

This paper presents a description of the evaluation principle, which is not new but nonetheless has never been incorporated into a standard laboratory apparatus. Typical experimental results obtained from both the reciprocating- and turbo-jet-engine programs are also included.

Evaluation Principle

Storage conditions for equipment exposed to the atmosphere are generally considered to be the most severe in tropical climates, where moisture condenses on the exterior surfaces during the night and is thoroughly dried out during the heat of the day. Less severe conditions are encountered in other areas, but corrosion is still associated with the daily cycle in atmospheric conditions. To achieve a similar cycle in the test apparatus, the relative humidity and temperature of the atmosphere were maintained constant, while the temperatures of the specimens were controlled over a prearranged cycle. The exposed surfaces of the specimens thus alternated between a moist condition—resulting from a fine, even dispersement of water droplets—and a thoroughly dry condition. A gentle, pulsating circulation of air was passed over the VCI material under investigation before reaching the test-specimen area.

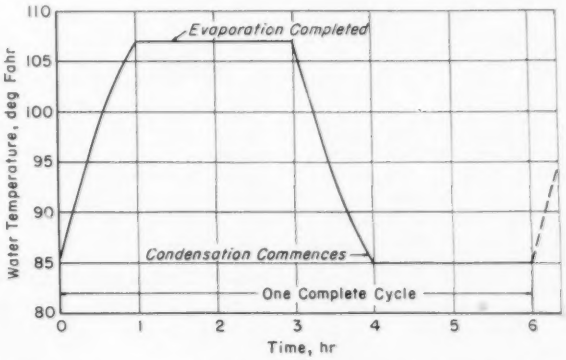

Fig. 1.—Temperature Variations on Test Specimens During One Cycle.

THEODORE J. NUSSDORFER, mechanical engineer, Arthur D. Little, Inc. has been engaged in work on preservation of aircraft engine cylinders against corrosion, a study of the factors affecting the accuracy of rocket-propelled projectiles, and problems relating to ballistics.

DAVID O. WHITE, a member of the Engineering Physics Group of Arthur D. Little, Inc., has been working on the evaluation and application of volatile corrosion inhibitors in the preservation of aircraft engines.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] Tentative Method of Salt Spray (Fog) Testing (B 117 – 54 T), 1954 Supplement to Book of ASTM Standards, Part 2, p. 349

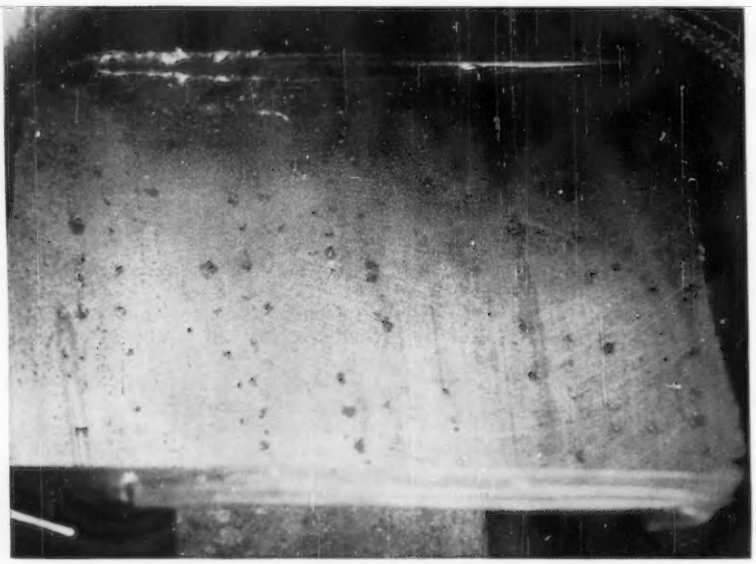

Fig. 2.—Photograph of Condensation on Test Specimen.

To evaluate inhibitor effectiveness, the corrosion rates on test specimens and the rate of inhibitor depletion were observed. In the tests conducted to date, only visual estimates of corroded area have been made.

Figure 1 presents the temperature variations of test specimens during one cycle. The air dry-bulb temperature was set at 108 F and the dew point at 85 F (50 per cent relative humidity). The evaporation period began with a 1-hr gradual change from 85 F to 108 F and ended with a 2-hr period at a constant 108 F, to assure a thorough drying of the specimen; the condensation period started with a 1-hr gradual change down to the dew point temperature and ended with a 2-hr period at that temperature, so that corrosion products and electrical potentials would have time to develop. Figure 2 shows the quality of the condensation produced on a test specimen. It is important that the degree of condensation be so controlled that the contaminants from either the atmosphere or the corrosion process are not washed off.

Results on Reciprocating Engines

Since the cylinder walls of reciprocating engines were the critical areas to protect, an experimental technique was designed to evaluate an inhibitor on the internal surfaces of full-scale cylinder assemblies. To simulate uniform and typical field conditions, each cylinder was run on a single-cylinder engine before installation in the corrosion apparatus. The water temperature was cycled and the water circulated around the outside of the cylinder assembly in order to produce condensation and evaporation alternately on the cylinder walls. The air flow within the cylinder and the cabinet carried the inhibitor and moisture. A bellows-type air pump, operating at a rate of 28 strokes per min., produced a pulsing flow of about 1 cu ft per min through each cylinder. This unsteady flow prevented the influence of uniform-velocity-pattern corrosion. No effort was made to eliminate leakage in the air system; therefore, oxygen depletion in the apparatus did not become a factor. The portion of the cylinder assembly protruding below the watertight box offered a means of inspection.

Figure 3 shows the corrosion developed on an unprotected cylinder which had been exposed to four complete cycles (a 24-hr period). The clear area at the bottom of the cylinder represents the space occupied by the piston and rings. About 80 per cent of the exposed area was corroded; on the other hand, cylinders protected with one of the commercial VCI materials and exposed for a period of 700 hr, showed evidence of corrosion on approximately 15 per cent of the wall area.

The value of a testing technique depends upon the degree of correlation between it and field results. Fortunately, the Navy Bureau of Aeronautics

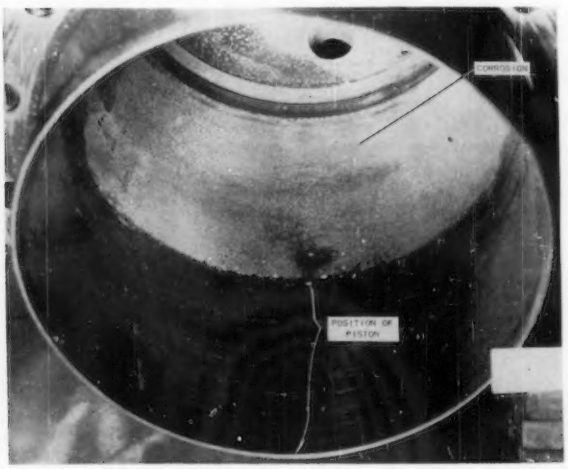

Fig. 3.—Corrosion Development on Unprotected Cylinder Wall After 24-hr Exposure (4 cycles).

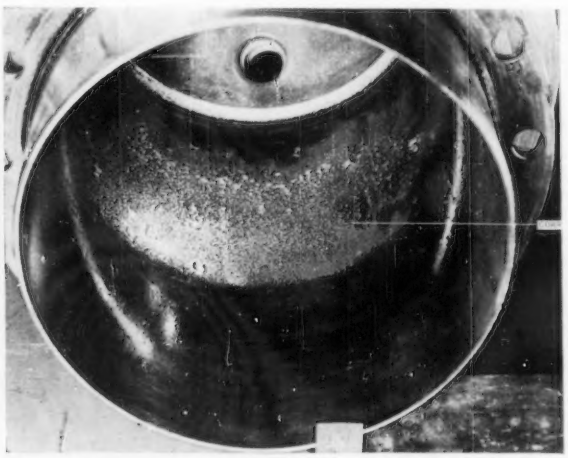

Fig. 4.—Typical Corrosion Development on Cylinder Protected with Light Preservative Oil; 2-Week Exposure.

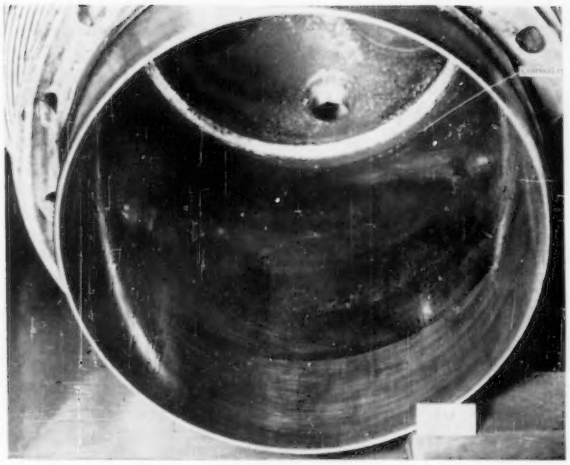

Fig. 5.—Typical Corrosion Development on Cylinder Protected with Light Preservative Oil and VCI; 2-Week Exposure.

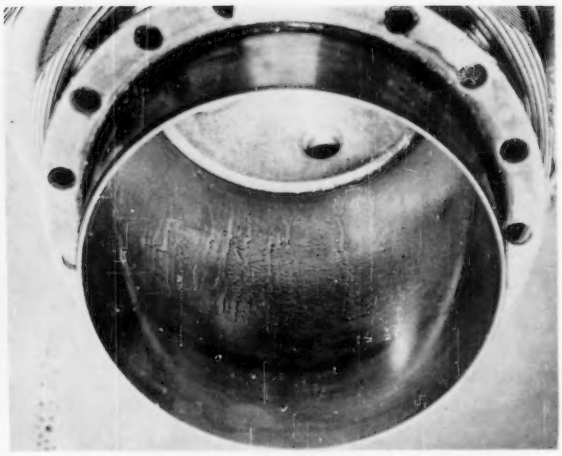

Fig. 6.—Appearance of Cylinder Wall Coated with a Thixotropic Preservative Oil; 3-Week Exposure.

had initiated a field evaluation of several preservation oils and a commercial volatile inhibitor at approximately the same time these laboratory tests were begun; 22 overhauled engines were forwarded to five exposure locations on the West Coast and South Pacific areas. Conventional lightweight preservative oils, such as AN-VV-C-576 mixtures, appeared to offer protection over short periods of time only; however, when used in conjunction with a volatile inhibitor, the oils achieved satisfactory protection—in several instances, for a 2-yr period. A thixotropic-type engine preservative oil used without the supplemental protection of a volatile inhibitor also proved satisfactory for a similar period.

Typical examples of corrosion development in the laboratory are shown in Figs. 4, 5, and 6; corrosion rates established from the study of many cylinders are presented in Fig. 7. The cylinders in which the light preservative oil was evaluated had been aspirated at the time of shutdown and then placed in the cycling apparatus without benefit of a VCI atmosphere. The appearance of the cylinder walls after about 2 weeks is shown in Fig. 4. Another cylinder sprayed with the preservative oil and stored for 3 months in an airtight container was evaluated in the corrosion apparatus. Typical corrosion developed at approximately the same rate as that observed with an unprotected cylinder (Fig. 3). The VCI atmosphere was then evaluated in cylinders aspirated with the light preservative oil. Figure 5 depicts the condition of such a cylinder after a 2-week exposure. Some cylinders went 4 weeks with no further corrosion. The thixotropic preservative oil (MIL-C-5545) also provided excellent protection to the cylinders; Fig. 6 shows a cylinder after a 3-week exposure. When corrosion did occur with this oil, it was usually the result of faulty application.

These three types of preservative treatment are compared in Fig. 7. Consistently good results were obtained with the thixotropic preservative oil and the lightweight preservative oil plus VCI. The lightweight oil film, however, occasionally failed, even when the variable of storage time was not included. The similarity of results reported on Navy field use of these materials led to the conclusion that the newly developed test procedure was a useful means of evaluating volatile corrosion inhibitors, as well as preservative oils.

Results on Turbo-Jet Engines

When Navy squadrons began flying turbo-jet-powered aircraft in seacoast areas, corrosion became a problem particularly in the axial-flow type of engine. The salt spray sucked into the compressor section attacked the stainless steel blades and magnesium components. The standard maintenance procedure of spraying a preservative oil into engines upon shutdown was ineffective, particularly in the rear half of the compressor, where satisfactory distribution of oil was not achieved. A VCI material offered a simplified procedure for reaching the whole compressor section. Consequently, the corrosion apparatus developed originally for the study of reciprocating engines was modified to accommodate blades and specimens of other metal components from a typical jet engine.

The corrosion-inducing conditions described previously were duplicated, except that an open instead of a closed air-flow pattern was used (Fig. 8). A pulsing air flow entered the bottom of the cabinet and passed successively over heaters, humidifying trays, and a bed of VCI material before reaching the outlet above the test-specimen area. The average air velocity in the test area approached 4 ft per min. The mounting

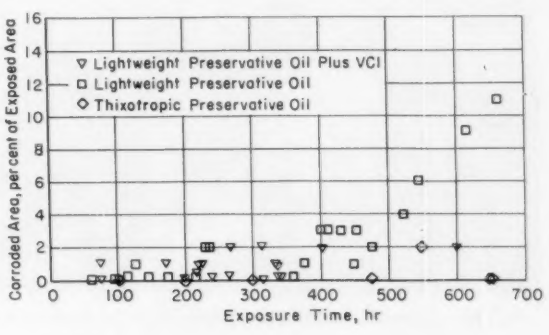

Fig. 7.—Laboratory Corrosion Rates of Several Preservation Methods.

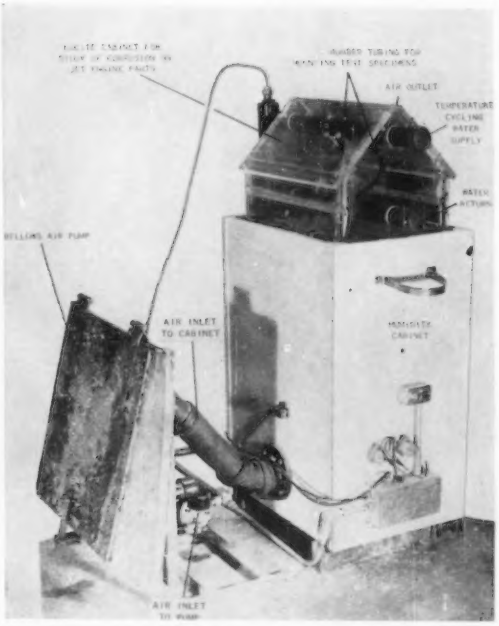

Fig. 8.—Cycling Apparatus for Study of Corrosion on Jet-Engine Components.

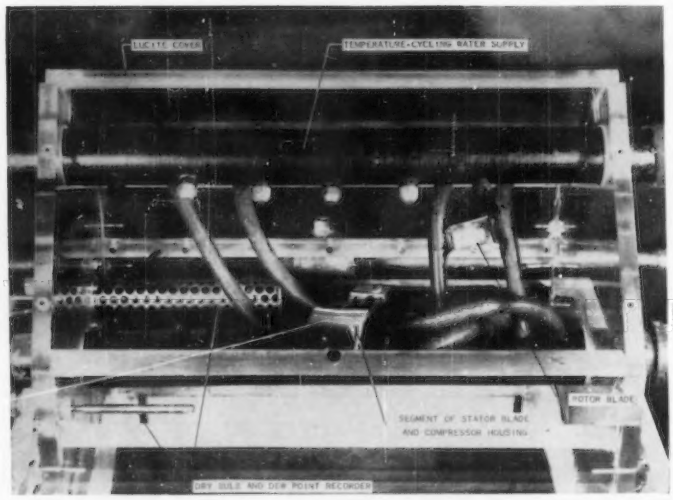
LUCITE COVER
TEMPERATURE-CYCLING WATER SUPPLY
ROTOR BLADE
SEGMENT OF STATOR BLADE AND COMPRESSOR HOUSING
DRY BULB AND DEW POINT RECORDER

Fig. 9.—Close Up of Specimen Mounting System.

for specimens of random shape is pictured in Fig. 9. Neoprene tubes were attached to opposite ends of test specimens and to the same temperature-cycling water supply used for controlling the cylinder-wall temperature. To effect the heat transfer necessary to produce the desired condensation, the specimens were inserted directly into the water through a slit in the tubing. Leakage around the specimens was prevented by a commercial sealer. Condensation and corrosion development were readily visible through the lucite cover.

Before being placed in the corrosion apparatus, each specimen was sprayed and dried twice, to contaminate it with sea water. Installation during the evaporation cycle provided sufficient time for inhibitor deposition prior to the start of corrosion-inducing conditions. Specimens were left in the apparatus until severe corrosion developed or until the end of a 2-week period. Figure 10 depicts an unprotected stainless steel rotor blade from a J-34 jet engine during the first condensation and evaporation cycles. The residual salt deposit shown in Fig. 10(*b*) is the result of the evaporation of moisture shown in Fig. 10(*a*). After 48 hr (8 cycles), severe pitting occurred (Fig. 11). The use of a volatile inhibitor, however, controlled the corrosion development to a few per cent of the surface area in a 2-week period. It is too early to compare results of laboratory and field tests of VCI materials in jet engines, although the corrosion formation is similar.

Comparison with Other Techniques

During the experimental programs, some tests were made with standard protective coatings. A comparison of these results with those of field tests gave evidence of good correlation and suggested that this procedure may have

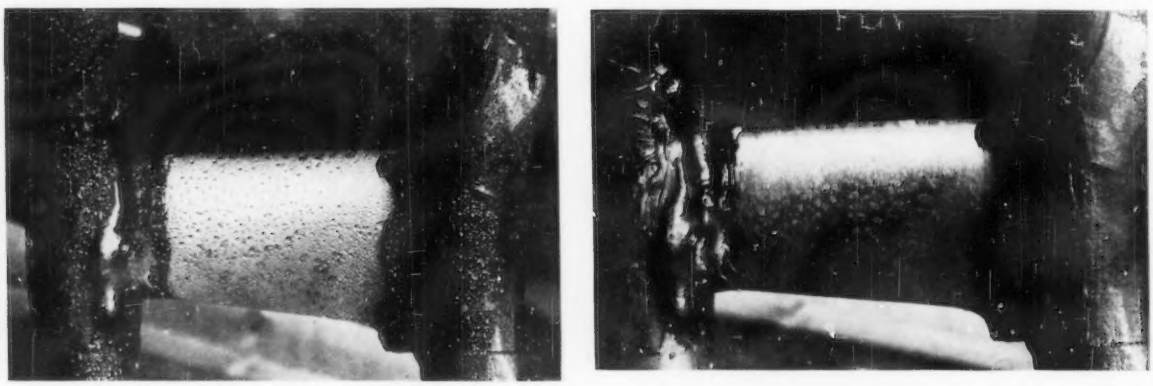

Fig. 10.—Corrosion-Inducing Conditions on a Jet-Engine Compressor Blade left, condensation period; right, evaporation period.

further value in the field of corrosion testing. Many different tests are described in the literature. R. M. Burns (5) recommends a cycling-type test because it is patterned after field conditions; however, he reports that there appears to be no general agreement in the cycle period or temperature range. K. G. Compton (6) states that high relative humidity and high temperature do not occur simultaneously, except in enclosures exposed to the sun and containing liquid water. Therefore, a cycling test which varies the specimen temperature might be preferable to one which varies the dew-point temperature. Sam Tour (7) uses a cycling rate of 15 times per hr, yet R. M. Burns (5) recommends a condensation period of at least 2 hr.

The test procedure described herein offers a research tool which combines many of the characteristics of a good corrosion test into one piece of equipment. It is not an all-purpose testing unit, but it does simulate atmospheric conditions more closely than the salt-spray and humidity cabinets.

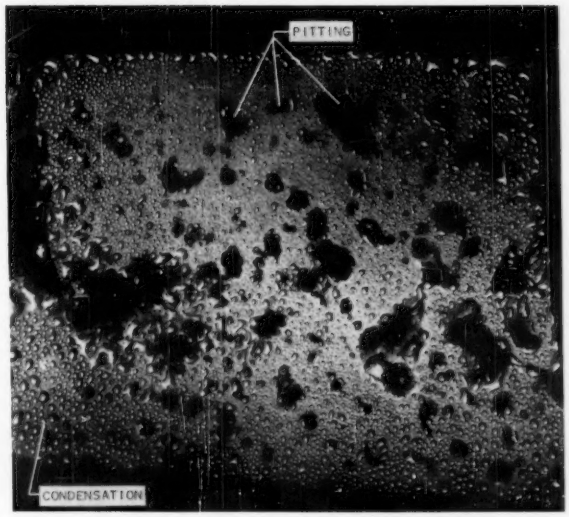

Fig. 11.—Rotor Blade Corrosion After 48-hr Exposure.

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(1) F. A. Champion, "Corrosion Testing Procedures," Chapter IV, John Wiley & Sons, Inc., New York, N. Y. (1952).

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(3) Thomson Boegehold Opinsky, "The General Motors Research Corrosion Test—A Cyclic Humidity Accelerated Corrosion Test for Sheet Steel," *ASTM Bulletin* No. 187, Jan., 1953, p. 47 (TPI).

(4) Louis Schlossberg, "Humidity Cabinets Don't Tell the Whole Story," *Steel*, Vol. 135, No. 2, July 12, 1954, p. 114.

(5) R. M. Burns, "Laboratory Corrosion Tests," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 17, p. 299 (1945).

(6) K. G. Compton, "Corrosion in the Tropics," *Transactions*, Electrochemical Soc., Vol. 91, p. 705 (1947).

(7) Sam Tour, "Three Accelerated Corrosion Tests for Materials and Finishes," *Materials and Methods*, Nov., 1953, p. 110–113.

Discussion of Paper on Relaxation of High-Tensile-Strength Wire for Use in Prestressed Concrete[1]

W. R. JOHNSON.[2]—We were quite interested in this paper, because the wire studied by the authors is the same material used in the manufacture of many types of springs. A few of our observations may be pertinent, despite the difference in fields of interest.

Springs are usually coiled direct from the bundles of hard-drawn wire. As has been pointed out by the author, the elastic limit of this material is so low that relaxation takes place at very low stress levels. Consequently almost all compression springs are heat-treated or stress-relieved by the manufacturer. We have found however, that heat-treating at temperatures of 750 to 800 F, as used by the authors, is too high for most spring purposes. A lower temperature heat treatment at about 450 F may raise the elastic limit about 50 per cent and the tensile strength as much as 5 to 10 per cent, but the heat treatment at 750 to 800 F lowers the tensile strength somewhat.

Springs are generally stress-relieved in a batch type operation, and the heating times are necessarily longer than the authors' 5 to 15 sec. We have obtained some time-temperature data that indicate that even short times at temperatures of 750 F cause appreciable lowering of the torsional yield strength. For lack of knowledge to the contrary, we might assume that the torsional and bending yield strengths show similar behavior.

We have carried out relaxation tests on springs, loading them under constant deflection for periods of time of up to 1000 hr. Within the precision of measurement, the data plotted as straight lines on a semilog chart; we did not observe the downward trend noticed by the authors. Otherwise the data gave similar plots, with the slope of the curves varying with the applied stress.

We did not expect the result reported by the authors that the stress-relieved wire *SR* would relax more than the *SO* wire at higher stresses. Is it possible that this is due to the high-temperature stress relief lowering the yield point of the wire? Can the test be repeated using a 450 F stress relief temperature?

In our experience, overstressing, analogous to the setting out of springs,

[1] G. McLean and C. P. Siess, "Relaxation of High-Tensile-Strength Steel Wire for Use in Prestressed Concrete," ASTM BULLETIN, No. 211, January, 1956, p. 46 (*TP18*).

[2] Research metallurgist, Wallace Barnes Co., Bristol, Conn.

definitely decreases the relaxation of the spring under load. However, the amount of overstressing that can be done is usually limited by spring design. If a spring must not relax or lose load in service to the slightest degree when under appreciable stress (in excess of 50 per cent of the tensile strength), in general, it must be heat set that is, overstressed and then heated while under load to develop a favorable residual stress situation.

C. P. SIESS—(*authors' closure*).—The comments by Mr. Johnson regarding the heat treatment of the stress-relieved wire should be of interest to the manufacturers of this type of wire for use in prestressed concrete. In clarification, it should be explained that the heat treatment of the wires subjected to relaxation tests was done by the manufacturers and not by the authors. The type *OR* wire is believed to represent a standard product supplied for use in prestressed concrete; its heat treatment was as described in the paper. However, the type *SR* wire was a special product, being machine-straightened after drawing and stress-relieved at 750 F for 15 *min;* the 5 to 15 *sec* referred to in the paper applied only to type *OR* wire. The type *SO* wire was obtained from a manufacturer of prestressed concrete products and had been straightened by him.

Seal of Approval for Plastic Pipe

THE SOCIETY of the Plastics Industry, Inc., and the National Sanitation Foundation jointly announce an Identification Program that will assure the public of a safe, uniform quality in plastic pipe identified by the Foundation for use in systems transporting drinking water. This program was effective February 1, 1956.

The program for applying the National Sanitation Foundation Seal of Approval to plastic pipe, thus identifying it for use in the drinking water field, is the result of a research program of toxicity and taste studies sponsored by the plastics industry more than three years ago.

The National Sanitation Foundation is a nonprofit corporation carrying on research in the field of public health and sanitation. Its headquarters are at the School of Public Health of the University of Michigan. Valuable assistance in this study was given by an Advisory Committee of public health officials and technical representatives of the thermoplastic pipe industry.

This study included 22 samples of plastic pipe to determine their suitability for underground use in conducting cold drinking water. The tests performed were designed to show whether or not any substance that might be deleterious to health would be extracted from plastic by an aggressive potable water, and if the passage of water through plastic pipe would affect the appearance, odor, or taste of the water.

It is recognized that the physical properties and performance of plastic pipe in service also are of paramount importance. The Thermoplastic Pipe Division of The Society of the Plastics Industry has under way at another laboratory a long-term program to develop performance characteristics and test procedures. The results of these investigations are being made available to Subcommittee XVII on Plastic Pipe, of ASTM Committee D-20 on Plastic, which functions under the joint sponsorship of the ASTM and SPI. (The activities of the joint committee have been covered in previous issues of The BULLETIN, see January, 1956 issue, page 11.)

The SPI-NSF Identification Program will automatically require testing of raw materials suitable for plastic pipe. New materials, therefore, must pass the Foundation's tests.

OTHER SOCIETIES' EVENTS

June 3–6—**American Society of Refrigerating Engineers,** Annual Meeting, Sheraton Gibson Hotel, Cincinnati, Ohio.

June 3–8—**Society of Automotive Engineers,** Chalfonte-Haddon Hall, Atlantic City, N. J.

June 4–7—**Forest Products Research Society,** National Meeting, Asheville, N. C.

June 4–8—**American Foundrymen's Society,** Committee Week, Chicago, Ill.

June 5–8—**Materials Handling Institute,** Exposition, Public Auditorium, Cleveland, Ohio.

June 6–8—**American Nuclear Society,** Annual Meeting, Palmer House, Chicago, Ill.

June 6–8—**American Society for Quality Control,** Annual Convention, Hotel Mt. Royal, Montreal, Can.

June 11–12—**Malleable Founders' Society,** The Homestead, Hot Springs, Va.

June 11–15—**Society of Plastics Industry,** Annual Meeting and National Plastics Exposition, Commodore Hotel and New Coliseum, New York, N. Y.

June 17–20—**American Society of Agricultural Engineers,** Annual Meeting, Hotel Roanoke, Roanoke, Va.

June 17–21—**American Society Mechanical Engineers,** Hotel Statler, Cleveland, Ohio.

June 18–20—**American Society of Heating and Air Conditioning Engineers,** Shoreham Hotel, Washington, D. C.

June 18–20—**Gordon Research Conference on Petroleum,** Colby Jr. College, New London, N. H.

June 18–22—**Gordon Research Conference on Metals at High Temperatures,** New Hampton School, New Hampton, N. H.

June 18–22—**Gordon Research Conference on Stream Sanitation,** Kimball Union Academy, Meriden, N. H.

June 18–22—**National Association of Power Engineers,** Hilton Hotel, Fort Worth, Tex.

June 25–29—**Gordon Research Conference on Nuclear Chemistry,** Kimball Union Academy, Meriden, N. H.

June 25–29—**American Society for Engineering Education,** Iowa State University, Ames, Iowa.

July 2–6—**Gordon Research Conference on Polymers,** Colby Jr. College, New London, N. H.

July 2–6—**Gordon Research Conference on Coal,** New Hampton School, New Hampton, N. H.

July 2–6—**Gordon Research Conference, Chemistry and Physics of Isotopes,** Kimball Union Academy, Meriden, N. H.

July 9–13—**Gordon Research Conferences on Textiles,** Colby Jr. College, New London, N. H.

July 9–13—**Gordon Research Conference on Radiation Chemistry,** New Hampton School, New Hampton, N. H.

July 9–13—**Gordon Research Conference on Solid State Studies in Ceramics,** Kimball Union Academy, Meriden, N. H.

July 16–20—**Gordon Research Conference on Corrosion,** Colby Jr. College, New London, N. H.

July 16–20—**Gordon Research Conference on Organic Coatings,** New Hampton School, New Hampton, N. H.

July 23–27—**Gordon Research Conference on Instrumentation,** Colby Jr. College, New London, N. H.

July 23–27—**Gordon Research Conference on Chemistry and Physics of Metals,** New Hampton School, New Hampton, N. H.

July 30–Aug. 3—**Gordon Research Conferences, Elastomers,** Colby Jr. College, New London, N. H.

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column

NOTE—These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.

Donald H. Anderson has been appointed assistant superintendent, Industrial Laboratory, Eastman Kodak Co., Rochester, N. Y.

Robert S. Aries, chemical engineer, R. S. Aries and Associates, New York City, and Melvin Wolkstein of Brooklyn Polytechnic Institute have been given an award of $500 by the Tall Oil Division of the Pulp Chemicals Assn. The joint award was given for their studies on the esterification of tall oil with glycerol.

Hugo W. Biskeborn has been appointed chief engineer, The Ansonia Wire & Cable Co., Ansonia, Conn. Mr. Biskeborn, who has a long and successful background in both power and communication cable engineering, has been cable research engineer since joining Ansonia in 1954.

Charles B. Bryant has retired as chief engineer of the Technical Board of the Wrought Steel Wheel Industry, Chicago, Ill. Affiliated with ASTM since 1933, Mr. Bryant has served on a number of the technical groups including Committee A-1 on Steel.

I. M. Colbeth has retired as chemical director, The Baker Castor Oil Co., Bayonne, N. J.

Steve M. Dufala, formerly with the U. S. Department of the Air Force, George Air Force Base, Victorville, Calif., is now associated with Lake Shore Electric Corp., Bedford, Ohio.

Theodore C. DuMond, until recently editor of *Materials and Methods*, Reinhold Publishing Corp., New York City, is now vice-president, Gale Benn Associates, New York City.

John L. Ernst has been named a section head in the technical service unit of the Esso Research and Engineering Co., Linden, N. J. In his new post he is responsible for certain of the firm's activities in the polymers field. He had been a group head.

Carl Frederick Floe has been elected a director of **Walworth Co.,** New York City manufacturer of valves and pipe fittings. Dr. Floe is professor of metallurgy and assistant provost at the Massachusetts Institute of Technology. For many years he has served industry as a consultant, particularly in the field of service behavior of metals and surface hardening of steel. In announcing the election of the new director, the company president, Fred W. Belz said: "The importance of research and product development to the future of Walworth dictates that research have qualified representation on the policy level such as Dr. Floe can give."

Richard J. Frazier, formerly research engineer, Washington Brick Co., Washington, D. C., is now general plant manager, Anchor Concrete Products, Inc., Buffalo, N. Y.

Albert P. Gagnebin has been appointed Manager, Nickel Sales Dept., The International Nickel Co., Inc., New York City, succeeding Ransom Cooper, Jr., who is retiring after 33 years' service. Mr. Gagnebin has been associated with International Nickel since 1930. He was co inventor of the company's ductile iron.

Neil B. Garlock, formerly section chief, paint research, The Eagle-Picher Co., Joplin, Mo., is now chief chemist, National Paint, Varnish and Lacquer Assn., Inc., Washington, D. C.

An appreciation to **Albert T. Goldbeck,** engineering director of the National Crushed Stone Assn., Washington, D. C., for 31 years of devoted service was given at the NCSA Annual Banquet in February in Chicago. Under the NCSA retirement plan, Mr. Goldbeck will relinquish his duties as engineering director in August. However, at the request of the Board of Directors he has agreed to continue with the Association on a consulting basis. Very active in ASTM for many years, Mr. Goldbeck is an Honorary Member of the Society.

Max Hansen, formerly manager, Metals Research Dept., Armour Research Foundation, Chicago, Ill., has been elected president, Deutsche Gesellschaft für Metalkunde, Frankfurt, Germany, for a three-year period, 1956 to 1958. Since his return to Germany a year ago, Dr. Hansen has been serving as vice-president, Metallgesellschaft, A. G., Frankfurt.

Gordon B. Harvey has accepted a position as sales manager, Curlator Corp., E. Rochester, N. Y. Until recently he was with Star Woolen Co., Bonded Fabrics Div., Cohoes, N. Y.

J. H. Higgins, for many years materials engineer, Camden Forge Co., Camden, N. J., is now on the metallurgical staff of the Pennsylvania Forge Co., Tacony, Philadelphia, Pa. Mr. Higgins will continue his membership on Committee A-1 on Steel and several subcommittees, also certain other metals groups.

Elmo C. Higginson, formerly with Snowy Mountains Hydro Electric Authority, Cooma, New South Wales, Australia, is now civil engineer, U. S. Bureau of Reclamation, Denver Federal Center, Denver, Colo.

Henry J. Jacobson, until recently associated with Schaible Co., Mariemont Plant, Cincinnati, Ohio, is now quality control consultant, Sutherland & Jacobson, Fort Thomas, Ky.

Dana B. Jefferson, president, Walker Manufacturing Co., Medfield, Mass., was elected vice-president of the National Screw Machine Products Assn.

Henry Maag, formerly Dipl. Ing. ETH, SIA, St. Gall, Switzerland, is now associated with F. C. Huyck and Sons, Rensselaer, N. Y.

W. B. F. Mackay has accepted a position as product development engineer, Atlas Steels, Ltd., Welland, Ont., Canada. He was previously on the faculty of the School of Mines and Metallurgy, University of Minnesota, Minneapolis.

James T. MacKenzie retired in April as technical director, American Cast Iron Pipe Co., Birmingham, Ala. He had been associated with Acipco for 44 years, devoting his entire time since 1918 to experimental and research work. After a short vacation, Dr. MacKenzie has become associated with Southern Research Inst. and also will be available as a consultant. Recognition of his contributions to the metalworking industries have been accorded by various organizations. He was recipient of a 1953 ASTM Award of Merit for longtime leadership in Committee A-3 on Cast Iron and for constructive service in other ASTM technical fields.

P. C. Mortenson, formerly administrative engineer, Western Hemisphere, Massey-Harris-Ferguson, Inc., Detroit, Mich., is now chief engineer, Vickers, Inc., Administrative & Engineering Center, in the same city.

Victor Siegfried has been appointed power cable engineer, The Ansonia Wire & Cable Co., Ansonia, Conn. He will be responsible for coordinating and developing the engineering of plastic insulated wire and cable for power uses. Mr. Siegfried, a past vice-president and director of AIEE, was formerly chief research engineer of the Electric Cable Works of American Steel and Wire Co.

Charles E. Smith, formerly research metallurgist, Mond Nickel Co., Ltd., D&R Lab., Birmingham, England, is now research chemist, Refractories Section, Pilkington Brothers, Ltd., St. Helens, Lancashire, England.

Foster Dee Snell, president of Foster D. Snell, Inc., firm of chemists and chemical

(Continued on page 72)

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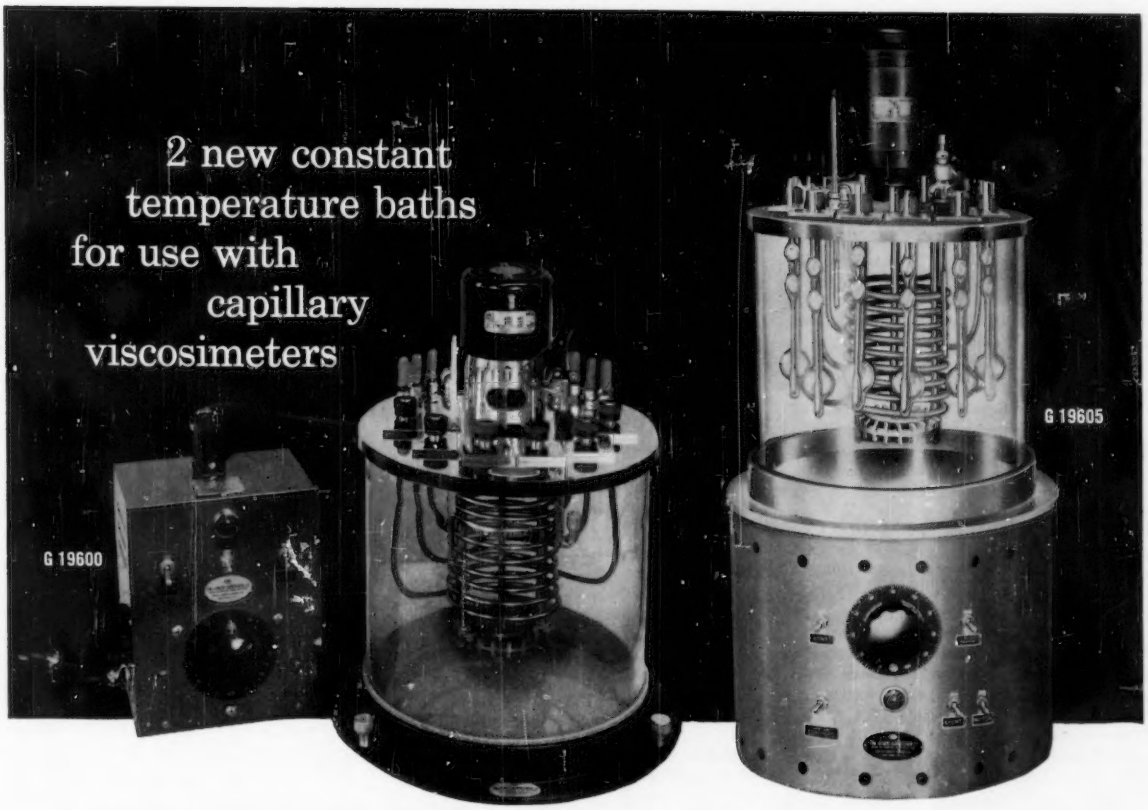

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(*Continued from page 67*)

engineers, New York City, has been appointed United States representative on the Water, Sewage, and Sanitary Wastes Division of the Applied Chemistry Section, International Union of Pure and Applied Chemistry. Other nations represented are Holland, Belgium, Great Britain, France, Switzerland, and Germany. The broad subject of international study is "the economic use of water and the solution of effluent problems in industry." Initially, specific fields to be given special attention are steel, beet sugar, pulp and paper, heavy chemicals, coal mining, and electroplating.

Maxwell Mayhew Upson, chairman of the board, Raymond Concrete Pile Co., New York City, was honored by 300 of his fellow workers at a dinner at the Waldorf-Astoria in April, in recognition of his eightieth birthday. He received a bronze plaque commemorating the event and simultaneously his more than 50 years as constructor, engineer, and inventor. When Mr. Upson joined the company in 1907 as a director, secretary, general manager and chief engineer, it had started job No. 50. Since then the company has completed some 32,000 contracts, which include 1275 construction projects in 50 world locations, valued at more than $1,400,000,000. Mr. Upson has represented the Raymond Concrete Pile Co. membership in ASTM since 1909.

James S. Vanick, metallurgist, The International Nickel Co., New York City, received the 1956 William H. McFadden Gold Medal of the American Foundrymen's Society "for outstanding contributions to the Society and for valuable service to the ferrous castings industry over a period of many years." Mr. Vanick has been very active in ASTM Committee A-3 on Cast Iron, of which he is a Past Chairman, as well as in other ASTM technical work.

Fred R. White has retired as chief engineer, Iowa State Highway Commission, in Ames. Mr. White, who had represented the Iowa Commission in ASTM for the past 35 years, may be addressed at 2003 Greenbriar Circle, Ames, Iowa.

Leslie V. Whiton, formerly with Consolidated Mining and Smelting Co. of Canada, has opened offices in White Plains, N. Y., for consultation on matters pertaining to the production and marketing of nonferrous metals.

Thomas W. Wilson has accepted a position as technical director, Amerotron Corp., Raeford, N. C. Until recently he was associated with The McCormick Spinning Mill, McCormick, S. C., as director of research.

Lyle F. Yerges, manager of industrial product development, U. S. Gypsum Co., Chicago, Ill., was elected president of the Acoustical Materials Assn. at its annual meeting in San Francisco in April.

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DEATHS . . .

Eugene Casson Crittenden, retired associate director, National Bureau of Standards, and internationally known scientist and expert on standards of physical measurement, died on March 28, 1956, at Garfield Hospital, Washington, D. C., at the age of 75. Perhaps best known for his achievements in the development and adoption of electrical and photometric standards, Dr. Crittenden was honored with the Gold Medal of the Illuminating Engineering Society in 1946 for "meritorious achievement conspicuously furthering the profession, art, or knowledge of illuminating engineering." In 1949 he was awarded the Department of Commerce Gold Medal for Exceptional Service, recognizing outstanding contributions to the work of the Bureau. Extremely active in many scientific and professional organizations, Dr. Crittenden represented the Bureau for a number of years on ASTM Committee B-1 on Wires for Electrical Conductors.

Harvey L. Curtis, principal physicist (retired), National Bureau of Standards, Washington, D. C. (Home address: 6816 Delaware St., Chevy Chase, Md.) Dr. Curtis, internationally known physicist, died April 17, 1956, at the age of 80. A member of the Bureau Staff from 1907 to 1946, he received world-wide recognition for his work in absolute electrical measurements. During World Wars I and II he directed extensive programs in ballistics research for the Navy. A member of many scientific and technical organizations, Dr. Curtis had been affiliated with ASTM since 1923. In 1948 he was elected to Honorary Membership in the Society, in recognition of longtime meritorious service to ASTM and eminence in his field. Through the years he was particularly active in the Society's work involving electrical insulating materials, having been a member of Committee D-9 on Electrical Insulating Materials for many years and its Chairman from 1930 to 1934, and serving on many subcommittees. He rendered notable service on the Administrative Committee on Standards from 1933 to 1939. He also was very active in Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts. Both Committees B-4 and D-9 elected him to committee honorary membership, in appreciation of sustained and valued contributions.

G. C. Dunwoody, chief engineer, Mephan Ferguson Pty., Ltd., Footscray, Victoria, Australia. Member since 1953.

Frank P. Fahy, consulting engineer, 31 Sidney St., New Rochelle, N. Y. (March 25, 1956). Member of Society since 1917. Member of former Committee A-8 on Magnetic Analysis from 1918 until 1936 when this group merged with Committee A-6. Member of Committee A-6 on Magnetic

(*Continued on page 74*)

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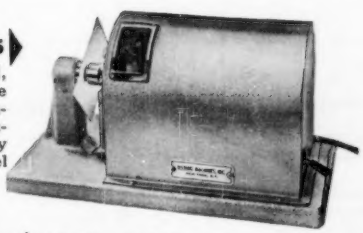

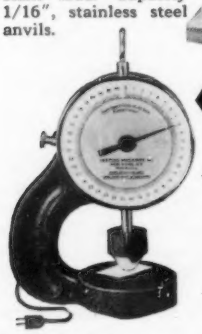

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(Continued from page 72)

Properties from 1920 until his death, participating for many years in activities of all subcommittees. Well known as an authority in the magnetic testing apparatus field, Mr. Fahy in his early years had been associated with General Electric Co. and the Pennsylvania Railroad Co. Since 1917 he had been engaged as a consulting engineer. He was author of many papers on the subject of magnetic properties and magnetic testing instruments, and inventor of the Fahy, Simplex P, Direct-Reading and Low Mu Permeameters, and the Super-H Adapter.

E. R. Hollinger, director, Furniture Finishes Division, Bradley Paint Co., Los Angeles, Calif. Member since 1948.

John Clifford Jones, consulting metallurgist, Aluminum Transatlantic, Inc., New York City (December 25, 1955). Member of Society since 1937, serving for the past nineteen years on Committee B-6 on Die-Cast Metals and Alloys and its Subcommittee I on Aluminum-Base Die-Casting Alloys; and on Committee B-7 on Light Metals and Alloys, Cast and Wrought, and its Subcommittees I on Aluminum and Aluminum Alloy Ingots, III on Wrought Aluminum and Wrought Aluminum Alloys, and VII on Codification of Light Alloys.

William H. Naegely, chemical engineer and director of laboratory, J. I. Case Co., Racine, Wis. (April 1, 1956). Member since 1927.

Weidlein Retires from Mellon Institute

THE RETIREMENT of Edward R. Weidlein as president of Mellon Institute was announced at a testimonial dinner for him in Pittsburgh, March 31, attended by 327 of his institute associates.

Weidlein has been with the institute for over 40 years, where he began as a senior fellow in 1912 and became an executive staff member in 1916. After serving as director for 30 years he was named president in 1951. In addition to many other activities for civic betterment, he has been a leader in smoke control since 1916. He was also a pioneer in the development of the synthetic rubber industry in this country.

He will remain on the board of trustees of the institute and will be available in an advisory capacity in the administration of the research programs. He will be in Europe for the next two months to conduct seminars on applied research in several countries, under the auspices of International Cooperation Administration.

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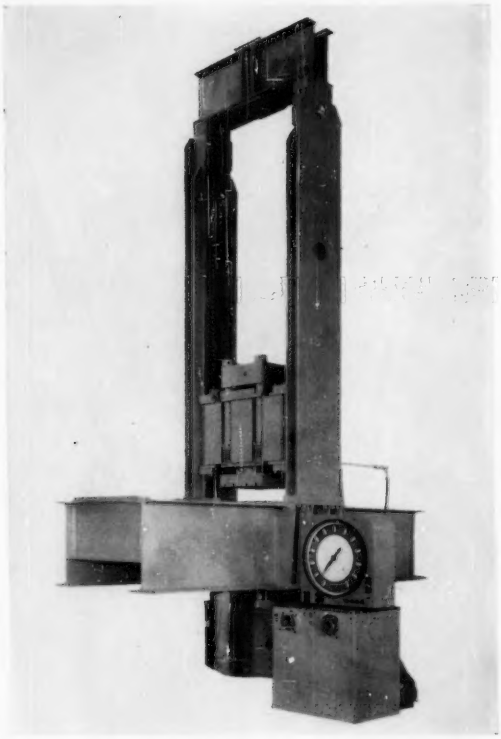

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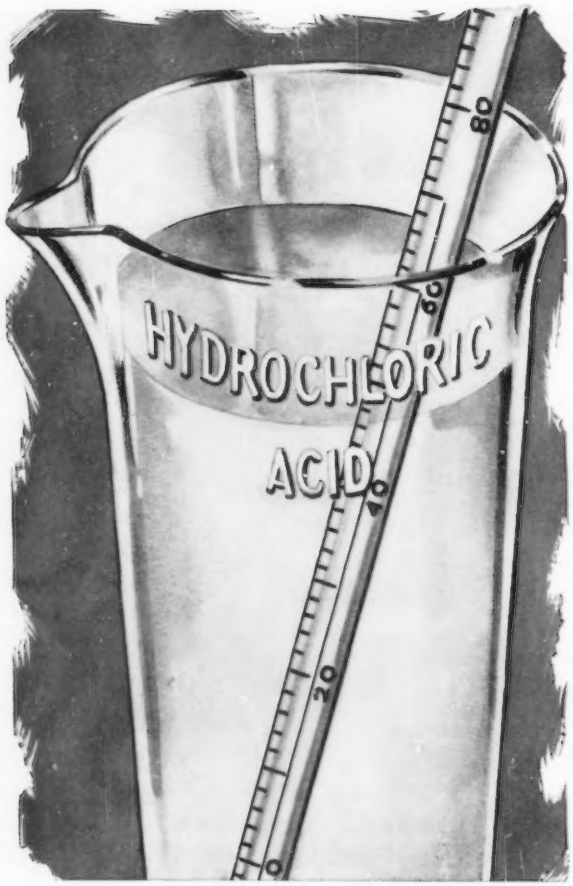

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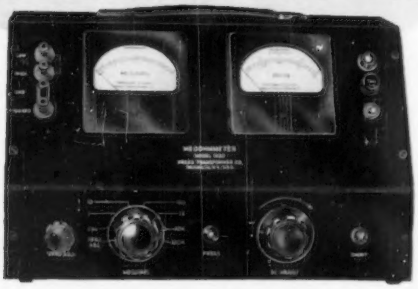

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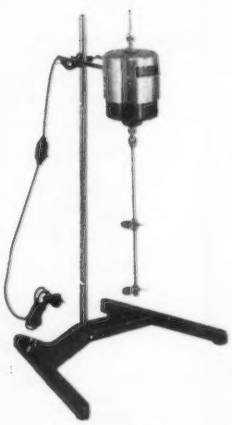

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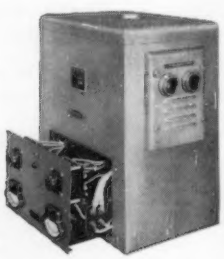

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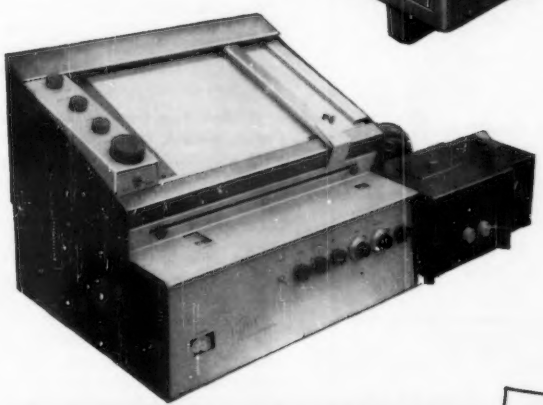

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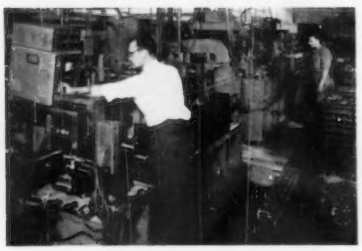

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Kaufman, J. G., research engineer, Box 772, Freeport Rd., New Kensington, Pa. [A]
Lancy, Leslie E., consulting engineer, Box 1200, R. D. #2, Ellwood City, Pa.
MacMullan, S. J., works metallurgist, Armco Steel Corp., Butler, Pa.
McKeever, L. A., manager, Inspection Dept., Pittsburgh Testing Laboratory, 1330 Locust St., Pittsburgh 19, Pa.
Romualdi, James P. R., assistant professor of civil engineering, Carnegie Institute of Technology, Pittsburgh 13, Pa. [A]

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Hatfield, Ira, director of research, Wood-Treating Chemicals Co., 5137 Southwest Ave., St. Louis 10, Mo.
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Kirkpatrick, R. T., engineer, Shell Chemical Corp., Veneuta, Calif. For mail: 5119 Hersholt Ave., Lakewood 11, Calif. [A]
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Kurg, Ivo Mart, aeronautical research scientist, National Advisory Committee for Aeronautics, Structures Research Div., Langley Field, Va. For mail: 133 Armstrong Dr., Hampton, Va. [A]
McLean, J. O., chief lubrication engineer, Reynolds Metals Co., 3rd and Grace Sts., Richmond 18, Va.
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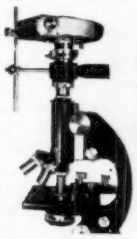

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Miller, Albert L., field engineer and sales engineer, Kux Machine Co., 6725 N. Ridge Ave., Chicago 26, Ill. For mail: Box 825, Buffalo 5, N. Y.

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Mitchell, J. E., quality control manager, Avondale Mills, Sylacauga, Ala. For mail: 306A S. Broadway, Sylacauga, Ala. [A]

Nelson, Ned H., executive vice-president, Superior Portland Cement, Inc., 1003 Seaboard Bldg., Seattle 1, Wash.

Van Sant, George M., physical testing supervisor, Reynolds Metals Co., Alloys Plant, Listerhill, Scheffield, Ala.

Weston, Henry M., research chemist, Reynolds Metals Co., Sheffield, Ala. For mail: 1404—34th St., Sheffield, Ala.

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Tubos de Acero de Mexico, S. A., Paseo de la Reforma 107, 9th Floor, Mexico, D. F. 4, Mexico.

Berthaud, Nadeleine, chief of laboratory, La Radiotechnique, 51 rue Carnot, Suresnes, Seine, France. For mail: 23 rue Clairaut, Paris 17eme, France.

Hull, Charles, assistant manager, O.P.D. Dept., Shell Petroleum Co., Ltd., 16 Finsbury Circus, London, E. C. 2, England.

Jubb, W., chief metallurgist, Bruntons (Musselburgh), Ltd., Wire Mills, Musselburgh, Midlothian, Scotland.

Lewin, Menachem, director of research, Institute for Fibers and Forest Products Research, Jerusalem, Israel. For mail: Box 8001, Jerusalem, Israel.

Nichols, William A., assistant chief engineer, Canadian Broadcasting Corp., Box 10, Snowdon, Montreal, P. Q., Canada.

Pennock, W. B., consultant, 339 MacLaren St., Ottawa 4, Ont., Canada.

Pilgrim, R. A., chief engineer, Mephan Ferguson Pty., Ltd., Box 4, Footscray, Victoria, Australia.

Stangebye, Einar Andreas, chief chemist, Stavanger Electro-Staalverk A/S, Joerpeland, Norway.

Smith, Alastair Ian, principal scientific officer, H.T.M.P. Section, National Physical Laboratory, Teddington, Middlesex, England.

Smith, John Hecker, chief engineer, Caterpillar Brazil, S. A., Caixa Postal 8239, São Paulo, Brazil.

Westminster Technical College, J. N. Long, Principal, Vincent Square, London S. W. 1, England.

Laboratory Supplies and Testing Equipment

USE READER SERVICE CARD ON PAGE 93 FOR REQUESTING ADDITIONAL INFORMATION

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses.

NEW PRODUCTS

Vibration Calibrator—Instrument designed to calibrate pickups or to measure vibration of nonmagnetic, metallic surfaces. *ACF Electronics.* 1094

Lead Shield and Counting Chamber—Position of end window Geiger tube is vertically adjustable for optimum counting efficiency in a new lead shield and manual sample changer. *Atomic Center, Inc.* 1095

Niptongs—Designed to grasp and release small radioactive or otherwise dangerous objects at a safe distance from the hands. *Atomic Center, Inc.* 1096

Ultraviolet Lamps—Special-purpose ultraviolet lamps for better observation of low-grade fluorescence, particularly in the critical areas of pale blue, light green, and red. *Black Light Corp. of America* 1097

Electronic Instrument Guards Production Line—Portable electronic instrument for checking metals without laboratory analysis. *Brush Electronics Co.* 1098

Running Torque Tester and Dynamometer—Recently released running torque testers and dynamometers have an accuracy of $\frac{1}{4}$ per cent and are furnished in 3 different models to test up to $\frac{3}{4}$ hp motors. *John Chatillon & Sons.* 1099

Vibration Meter—New, all-transistor vibration meter with a self-contained power source, which can be carried and used anywhere to measure the amplitude of vibrations in the 10- to 1000-cps frequency range. *Consolidated Electrodynamics Corp.* 1100

Low-Cost Leak Detector—Portable leak detector capable of the most exacting tests of either evacuated or pressurized systems. *Consolidated Electrodynamics Corp.* 1101

Soil-Tester—This unit provides a method of soiling the specimens for the evaluation of soil-retardant finishes on carpeting and fabrics. *Custom Scientific Instruments, Inc.* 1102

Air Gaging Instrument—New, improved column-type air gaging instrument designed to provide finer accuracy and maintenance-free operation as well as greater versatility, ease of operation, and longer gaging element life. *Dearborn Gage Co.* 1103

Nondestructive Tester—Ultrasonic bond analyzer will enable airframe, missile, and helicopter manufacturers to test the strength of adhesive bond material without destruction of the unit under test. *Du Mont Laboratories, Inc.* 1104

Capacitors—For use as laboratory reference standards in checking bridges and other measuring devices and for measuring capacitance. *Federal Telephone and Radio Co.* 1105

Heater—Heater expedites color tests of waxes by revised ASTM Method D 156. *Fisher Scientific Co.* 1106

4-Way Selector Valve—Solenoid-operated two-position 4-way selector valve provides flow control of air, oil, gas or other semilubricating fluids at pressures up to 600 psi. *General Controls Co.* 1107

Rectangular Meters—Newly developed $4\frac{5}{8}$-in. rectangular meters permitting maximum length of scale to an accuracy of $1\frac{1}{2}$ per cent are now available in a-c and d-c models. *Hickok Electrical Instrument Co.* 1108

X-Ray Machine—New mobile X-ray machine that increases the penetration of mobile X-ray from 4 in. of steel to 6 in. *Holger Andreasen, Inc.* 1109

Test Plug Kit—Set of 3 test plugs, for use in temporarily shutting off $\frac{1}{2}$ in., $\frac{5}{8}$ in., and $\frac{7}{8}$ in. OD tubing. *Imperial Brass Mfg. Co.* 1110

Transistor Oscillator—Crystal controlled transistor oscillator offers a complete plug-in signal source with fixed temperature and humidity environment for transistor and circuitry elements. *James Knights Co.* 1111

Rectangular Motors—Rectangularly shaped motors, designed to give the same output as comparable conventional round motors but in significantly less space; available in 6, 12, 24, and 32 ranges with outputs up to 140 ounce inches. *Leece-Neville Co.* 1112

Agitator—Agitator belt-drive unit is useful in any application where liquids must be stirred or agitated slowly and positively, and where there must be no possibility of contamination. *Little Giant Products, Inc.* 1113

Small Laboratory Furnace—Designed for research laboratories, small heat treating applications, etc. *L & L Manufacturing Co.* 1114

Deep Throat Micrometer—New micrometer with a deep throat frame has been designed especially for gaging the thickness of metal sheets and plates. *Lufkin Rule Co.* 1115

Micrometer Depth Gage—New micrometer depth gage with a graduated base measures the depth of holes, slots, projections, etc., with micrometer accuracy. *Lufkin Rule Co.* 1116

Water Analyzer—Electrolytic water analyzer for the measurement of small quantities of water in gas streams. *Manufacturers Engineering & Equipment Corp.* 1117

Gas Analyzer—This instrument, through macro-combustion by high-frequency furnace, reduces the time per determination of hydrogen to 5 min in zirconium, titanium, steel, and other alloys. *National Spectrographic Laboratories, Inc.* 1118

Hydrogen and Carbon Analyzer—An instrument utilizing a hi-frequency combustion furnace for the determination of hydrogen and carbon in titanium, zirconium, iron, and steel and the heat-resisting alloys of iron, cobalt, and nickel. *National Spectrographic Laboratories, Inc.* 1119

Paper Sampling—Samples, shielded from the atmosphere, are taken by cutting or tearing around the "Sample pro-taktor" and are then slipped into the moisture-vapor resistant Special "Sample pro-taktor" Pouch. *Paper Industry Instruments, Inc.* 1120

A Glove for Every Job—Industrial Glove line boasts 15 design innovations, a specific glove for virtually every industrial use. *Pioneer Rubber Co.* 1121

Versatile Stirrer—Developed especially for use in flash point tests, the Slo-Speed Stirrer can be adapted to any laboratory procedure requiring stirring at a slow, constant speed. *Precision Scientific Co.* 1122

Wafer Switch—Low-cost miniature rotary switches for instruments, computers, RF switching, and other electric-electronic applications. *Shallcross Mfg. Co.* 1123

Relay Checking—New series of instruments which speed and simplify checking and adjustment of relays, solenoids, stepping switches, and similar electro-mechanical devices for telephone, telegraph, and computer service. *Shallcross Mfg. Co.* 1124

Wig-L-Bug—New instrument for mixing and grinding powders. *Spex Industries, Inc.* 1125

Laboratory Press—Hydraulic laboratory press is especially suitable for vacuum

(Continued on page 84)

RESEARCH or PRODUCTION TESTING PROBLEMS?

many are solved with

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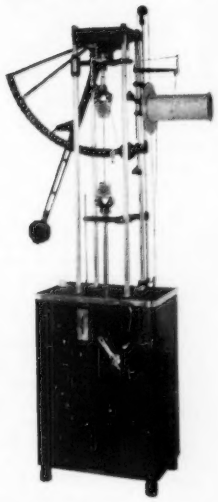
In paper testing, conforms to ASTM D 828, D 829, D 827, D 987, D 825

ADDITIONALLY

is used on many other materials including rubber, plywood, glass, paraffin, filaments, strip metal, wire, foils, cord, twine, synthetic fibres, yarn, plastics and textiles.



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Compression — Relaxation
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Cycling under limits of Load
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A rugged hydraulic system capable of running tens of thousands of tests a week.

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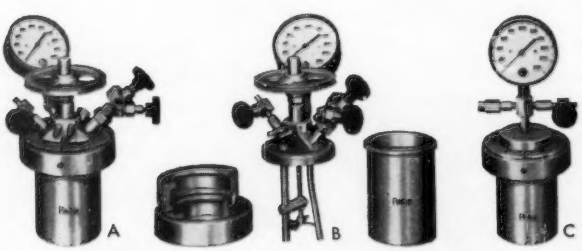
SERIES 4500 – STIRRER TYPE PRESSURE REACTION APPARATUS

Laboratories engaged in hydrogenation, alkylation, hydrolysis, polymerization, sulfonation and other pressure reactions will recognize many applications for this versatile stirrer-type apparatus.

An internal stainless steel cooling coil can be added, if desired. Maximum operating pressure is 1000 psig at 350 C.



The 1-liter bomb (A) weighs only 30 lbs. The same assembly with 2-liter cylinder weighs 34 lbs. Notice (B) how the head can be removed without disturbing the fittings. Special heads (C) with any combination of fittings can be substituted for the stirrer. Bombs are made of type 316 stainless steel or from other alloys on special order. Both 1 and 2 liter bombs operate in the same 1500 watt electric heater with variable voltage temperature control.

Ask your Parr Dealer for details or write direct to the factory for Spec. 4500.

PARR INSTRUMENT CO., MOLINE, ILLINOIS

EST. 1899 • MAKERS OF CALORIMETERS AND PRESSURE REACTION EQUIPMENT

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We hope you'll make it a particular point to visit Lindberg's Laboratory Equipment Division booth at the 12th Exhibit of Testing and Scientific Apparatus and Laboratory Supplies in Atlantic City the week of June 17.

New equipment for generating and utilizing protective atmospheres at elevated temperatures for research and pilot-type heat during application will be displayed and demonstrated. We're sure you'll find it interesting.

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Laboratory Equipment

LABORATORY DIVISION
Lindberg Engineering Company
2450 West Hubbard Street
Chicago 12, Illinois

CIRCLE 200 ON READER SERVICE CARD
PAGE 93

(*Continued from page 82*)

molding of specimens of potassium bromide, or the Perkin Elmer method. *Wabash Metal Products Co.* 1126

Potentiometer - Recorder—Electronic potentiometer-recorder of the null-balancing type is completely self-contained and requires only an external sensing device. *Wheelco Instruments Division* 1127

Petri Dishes—Disposable, presterilized plastic Petri dish for one-time use which eliminates entirely the cost of scraping, washing, sterilizing, and breakage. *Will Corp.* 1128

CATALOGS AND LITERATURE

Ultrasonic Systems and Applications—Benefits which may be derived from ultrasonic techniques in cleaning and degreasing, electroplating, drilling, and grinding operations are reported in new *Bulletin MW-103. Acoustica Associates, Inc.* 2048

Polyethylene—A revised catalog, detailing line of polyethylene and polyvinyl chloride sheet, bars, rod and blocks, moldings, and weldments, plus welding and spraying equipment. *American Agile Corp.* 2049

Automation Literature—*Catalog D-31* is a complete picture of the products and services offered for the field of automation. *Automatic Temperature Control Co., Inc.* 2050

Activated Charcoal—*Technical Bulletin E-1617* describes and illustrates many uses and advantages of activated charcoals and carbons in laboratory operations. *Barnebey-Cheney Co.* 2051

Infrared Detectors—"OptiTherm" infrared detectors used as sensing elements in radiometers, pyrometers, infrared spectrometers, and other infrared instruments are described in a new bulletin. *Barnes Engineering Co.* 2052

Electro-Optical Instruments—New 8-page catalog describing several electro-optical instruments for process control. *Barnes Engineering Co.* 2053

Vibration Damping Device—Four-page Technical Bulletin describes use and advantages of beryllium copper as the heart of a new vibration damping device for mounting electronic components in aircraft. *Beryllium Corp.* 2054

"Metal Digest"—Vol. 2, No. 1, of Metal Digest available—first anniversary issue. *Buehler Ltd.* 2055

Instantaneous Oscillograms—Electrograph offers 24 trace light-beam recording on electrosensitive paper with automatic sensitizing, dry developing and fixing, *Bulletin CGC-311. Century Electronics & Instruments, Inc.* 2056

Pumps for High Temperatures—Four-page, two-color *Bulletin 1040* describes and illustrates construction and operation of high temperature Series T canned motor Chempumps. *Chempump Corp.* 2057

Scientific Personnel—*Apparatus Digest* features article on "Career Opportunities *Versus* the Shortage of Scientific Personnel in Industry." *A. Daigger & Co.* 2058

Force Gage—*Bulletin 11 E* shows the capabilities of this instrument and how it can be adapted to dozens of different test setups. *W. C. Dillon & Co., Inc.* 2059

Titrimeter—Describes new instrument to speed analysis of mercaptans in gasoline, traces of halides, and a variety of other substances, including arsenites, antimony, thiosulfate, thallous ion, ferrocyanide, cyanide, cobalt, iron, nickel, vanadium, dichromate, permanganate. *Fisher Scientific Co.* 2060

Chemical Catalog—The 370-page book *Catalog 120-C* lists almost every chemical that is commercially available and of use to science. *Fisher Scientific Co.* 2061

Research Metallograph—In addition to the conventional types of illumination, the features include low power macrophotography, micro-hardness testing, surface finish testing and fluorescence microscopy. *William J. Hacker & Co., Inc.* 2062

Excitation Unit—An all-in-one excitation unit for spectrochemical analysis, *Catalog V2-56. Jarrell-Ash Co.* 2063

Computer Components—Containing illustrations, details, and outline specifications of mechanical and electrical components most frequently used in analog and digital computers. *Librascope, Inc.* 2064

X-Y Plotters and Input Accessories—Brochure containing illustrations, detailed specifications and applications of the X-Y Plotter for rapid graphic depiction of one independent variable in terms of another. *Librascope, Inc.* 2065

Homogenizer—Laboratory homogenizer, specially designed for research, pilot plant, or limited production operations is covered in a new 4-page *Folder LH-55. Manton-Gaulin Mfg. Co.* 2066

Spectrochemical Analysis—Spectrochemical analysis is described in a full-color brochure, illustrating graphically the scope of the science of spectroscopy and the steps involved in the spectrographic laboratory from sample preparation through the recording of line spectra on film and the subsequent interpretation. Available for framing for your laboratory wall. *National Spectrographic Laboratories, Inc.* 2067

Gamma-Ray Spectrometry—Latest issue of *the Nucleus* describes spectrometry techniques as applied to the measurement of gamma-emitting radioactive sources. *Nuclear Instrument & Chemical Corp.* 2068

Titrometer—*Bulletin 640-B* in addition to the applications of the unit, discusses such features as wide range, automatic plotting of titration curve, and control of titrant feed rate. *Precision Scientific Co.* 2069

(*Continued on page 88*)

ACCURACY

IN TEST RESULTS

is greatly increased by positive control of specimen temperatures

in the Model DMC

WEATHER-OMETER®

A constant volume of air at a controlled temperature in the heavily insulated cabinet, maintains uniform predetermined specimen temperatures regardless of variations in room conditions.

Automatic control of humidities up to dew point is available as optional equipment.

All automatic controls are located on the front panel of the Weather-Ometer directly above the door of the test chamber.

Both horizontal and vertical testing is available. Shallow containers are used for semi-liquid materials and vertical panels for solid materials.

Source of radiation is two Atlas enclosed violet carbon arcs.

Complete technical information on the DMC Model and other Weather-Ometers is contained in the new Weather-Ometer catalog. Copy on request.

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The Atlas Fade-Ometer has world-wide acceptance as the standard machine for testing the action of sunlight on materials.

A wide range of industrial products are tested daily in Atlas Fade-Ometers to determine the deterioration of materials due to the action of sunlight.

From 21 to 126 samples, depending on size, can be simultaneously exposed to the light of the Atlas Enclosed Carbon Arc. Temperature is controlled automatically and humidity is furnished by evaporation from a constant water reservoir. Operation of the Fade-Ometer is completely automatic, permitting the machine to be left in continuous 24-hour operation.

The Carbon Arc Lamp in the Fade-Ometer is the closest known duplicate of sunlight, both as to intensity and spectral distribution.

If your product is subject to deterioration by sunlight our engineers, with over a quarter of a century of experience in predetermining the fading of materials, can help you.

Catalog with technical information on request

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Manufacturers of accelerated testing equipment for over a quarter of a century.

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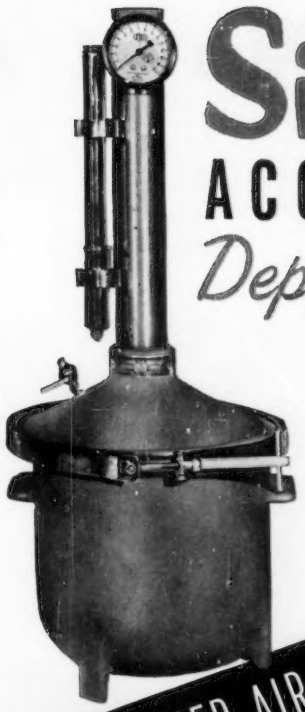

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This device provides for the accurate measurement of the air content of fresh concrete mixtures. The procedure is simple, the determination being made by the pressure method as developed in the laboratories of the Portland Cement Association. The unit is equipped with a unique stainless steel, toggle action clamp which insures a tight, secure seal during operation. The bowl and cover are made of lightweight magnesium alloy and the glass gauge is protected by a metal sleeve.

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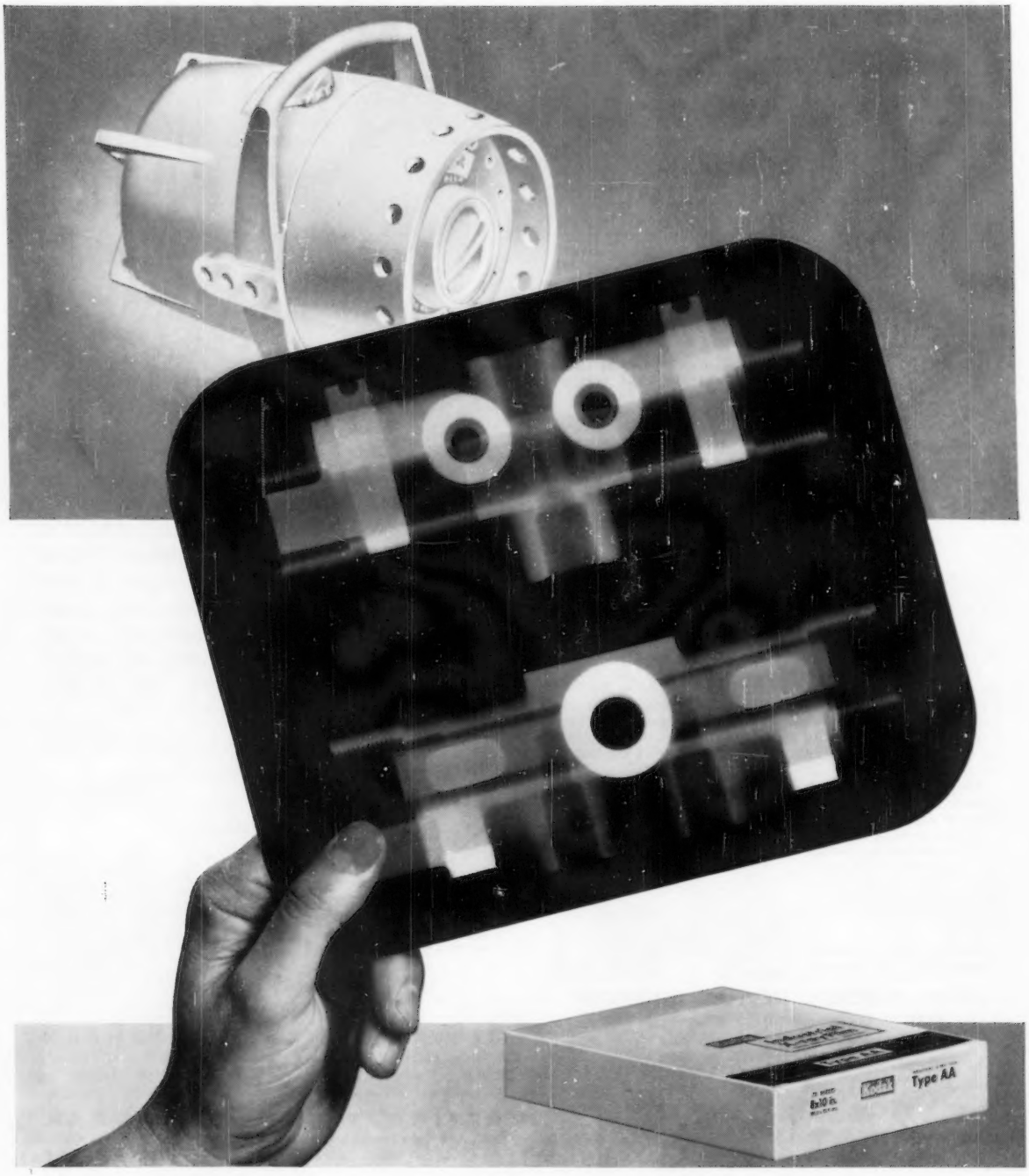
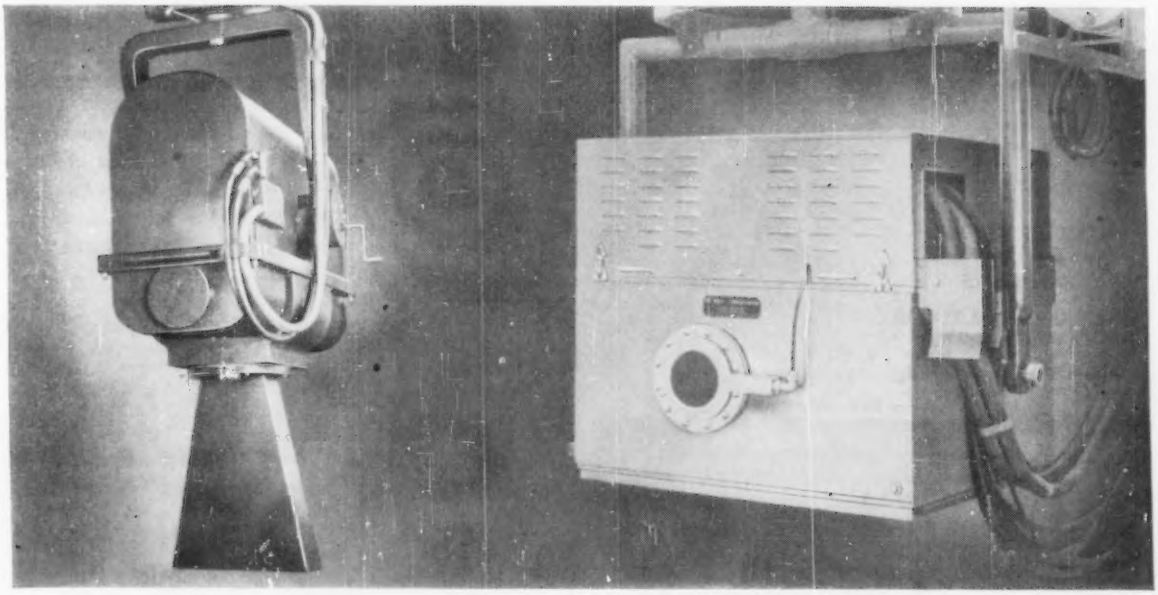


X-ray Film

specifically designed for Today's Radiographic Advances



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Out of the Kodak Research Laboratories comes a new and improved x-ray film designed to work hand-in-hand with today's other advances in industrial radiography. It is a film that retains the fine sensitivity characteristics which have made Kodak Type A the most widely used x-ray film in industry.

But more, while retaining these characteristics, the new film gives you greatly increased film speeds—speeds ranging up to more than twice the speed of Type A. So we have named this new film Type AA.

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Read what the new Kodak Industrial X-ray Film, Type AA, will do for you

- Reduces exposure time—speeds up routine examinations.
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- Provides increased radiographic sensitivity through higher densities with established exposure and processing technics.
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- Reduces the possibility of pressure desensitization under shop conditions of use.

EASTMAN KODAK COMPANY
X-ray Division, Rochester 4, N.Y.

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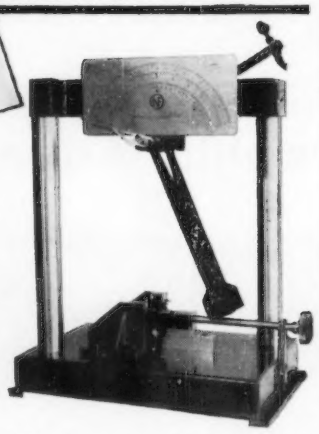
NATIONAL FORGE *Impact Tester*

for PLASTICS, CERAMICS LIGHT METALS and ADHESIVES



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- Two capacity combinations are available:

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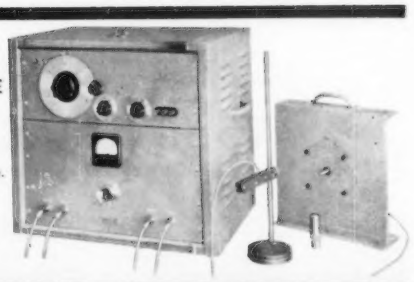

Measures structural strength of solid masses or materials It accurately tests such masses weighing up to 1500 pounds. Portable Pickup and Driver can be used at a distance from the cabinet for testing heavy or bulky objects.

Saves time, material and labor for testing samples of concrete or mortar mixes; metals; carbon; plastics and wood.

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(Continued from page 84)

Chromatography—1956 catalog, featuring complete listings of equipment, accessories, and chemicals currently being used in chromatographic analysis. *Schaar & Co.* 2070

Variable Resistors—File-size chart giving the essential electrical and mechanical characteristics of resistors. *Stackpole Carbon Co.* 2071

Temperature Test Chamber—Six-page bulletin, describes in detail the operating principle and procedure of the TC-2A Temperature Test Chamber and lists complete specifications as well as all maintenance information. *Statham Development Corp.* 2072

Spectrophotometry—Reference table of spectrophotometric absorption cells and cell compartment assemblies. *Will Corp.* 2073

INSTRUMENT COMPANY NEWS

Central Scientific Co., Chicago, Ill.—Virgil E. Goodwin has been named manager of the Birmingham, Ala., branch of Central Scientific Co.

Consolidated Electrodynamics Corp., Pasadena, Calif.—Joseph T. Johnston has been appointed to head an engineering consulting group on guided missile instrumentation of the Advanced Electronic Data Laboratory.

Gardner Laboratory, Inc., Bethesda, Md.—Gardner Laboratory announces complete facilities are available for the development of new instruments as well as the handling, production, and marketing of all devices within the field. The laboratory and technical staff are available for evaluating the many optical instruments manufactured.

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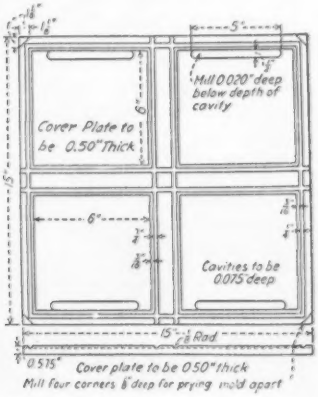
We supply molds and dies for making accurate rubber test strips and slabs; also molds for flex test, compression set test equipment, adhesion test; also molds for making plastic test samples. In addition, we offer a line of hand tools for working rubber and plastics. Write us your needs.

BENCH MARKER
1" and 2" Centers


Mill 0.020" deep below depth of cavity
Cover Plate to be 0.50" Thick
Cavities to be 0.015 deep
0.515"
Cover plate to be 0.50" Thick
Mill four corners 6 deep for prying mold apart

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133 Brewery St., New Haven 7, Conn.
Pac. Coast: H. M. Royal, Inc., Los Angeles

Standard ASTM and Federal dies for cutting test tensile and tear strength samples and dies for slab curing carried in stock. Write for catalog.

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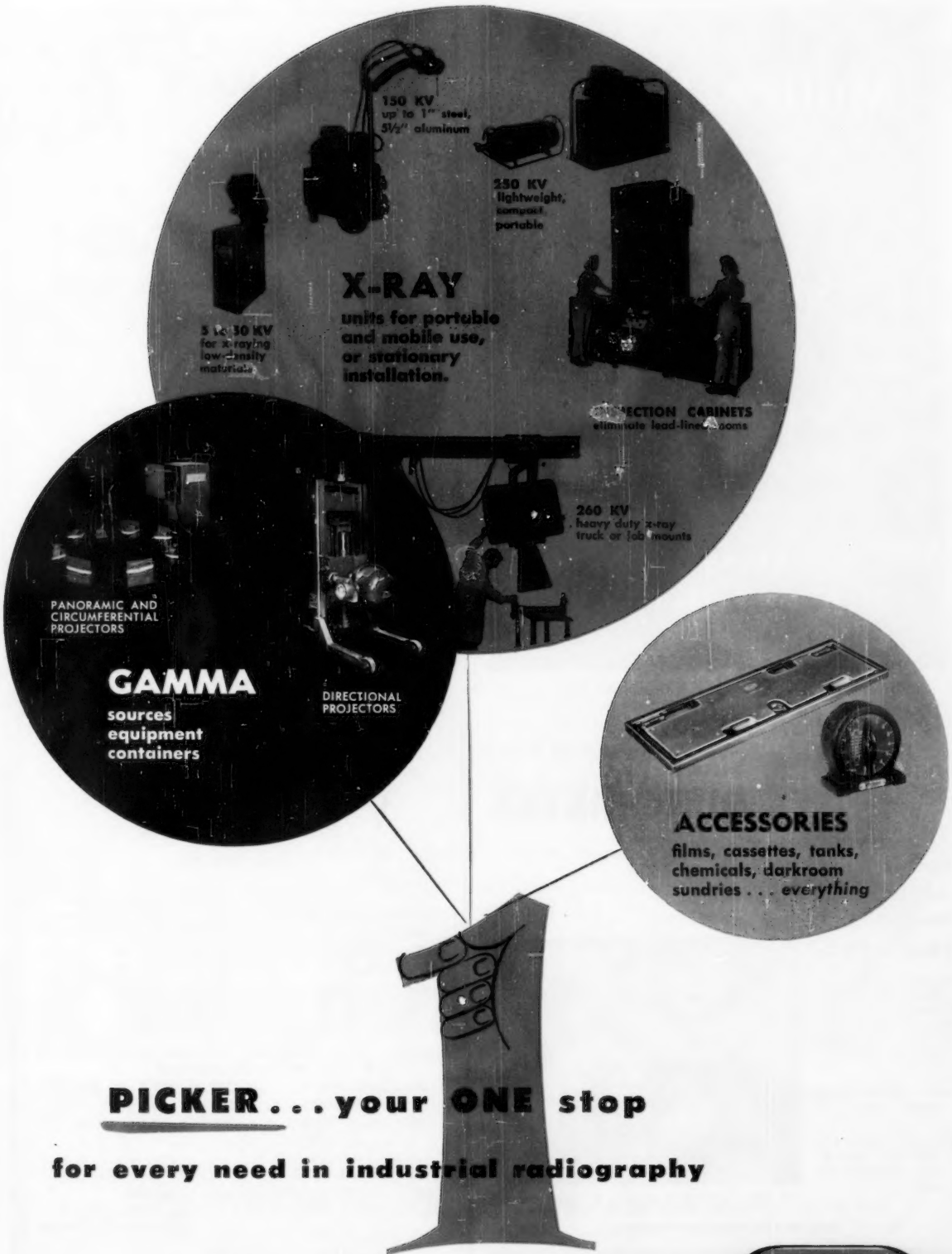

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Mullen Testers

Built to
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Specifications

Also Available in Capacities
up to 1500 Pounds
Bursting Strength

B. F. PERKINS & SON, Inc.
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Colorimeters
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Complete Electrophoresis Equipment

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Manufacturers of Scientific Instruments
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Shore DUROMETER

The "International Standard" for testing the hardness of rubber and other elastomeric materials

FEATURES:

- Quadrant or round dial for fast and accurate reading
- Conforms to ASTM D 676-55 T
- Small enough to be carried in the pocket
- Furnished complete with leatherette carrying case and standard test block.

The Shore Durometer is available in various models for testing the entire range of rubber hardness.

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Made by the manufacturers of the "Scleroscope", for testing the hardness of metals.

Shore INSTRUMENT & MFG. CO., INC.
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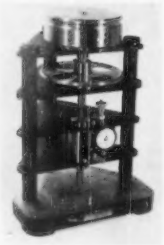

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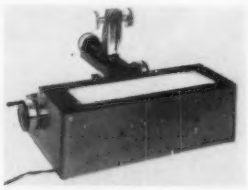

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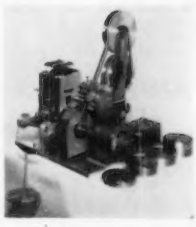

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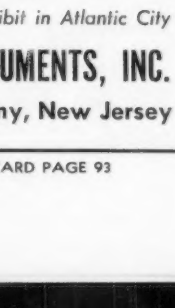

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Phase-Angle Differences to 0.0001 Radians

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The new G-R Type 1605-A Impedance Comparator provides in one completely self-contained package features and advantages which are not available in any other measuring equipment. This instrument performs rapid go/no-go impedance measurements by indicating directly the difference in both magnitude and phase angle between an unknown and standard impedance. No bridge balance is required — the two panel meters supply the answers simultaneously. Because this instrument compares two impedances which are nearly alike, it can perform measurements over very wide ranges of frequency and impedance level with an accuracy not easily obtainable otherwise.

The unusual combination of *precision* and *speed* in one instrument adapts the Impedance Comparator to a wide variety of applications in the laboratory or production-test line. Impedances of any phase angle and with a wide range of magnitudes can be measured. The two meter voltages, proportional to impedance-magnitude difference and phase-angle difference respectively, are available at the rear of the instrument to operate recorders or remote indicators of many types. Finally, an internal guard circuit is provided to make negligible the effects of stray capacitance when measuring remote unknown impedances.

Typical Uses Include:

- ★ *Rapid, yet precise testing, sorting and matching of components.*
- ★ *Drift investigations on precision components such as deposited carbon resistors where changes are typically small and high precision of measurement is needed.*
- ★ *Ganged potentiometers and capacitors can be checked for proper tracking and phase alignment.*
- ★ *In production testing of precision inductors, turns may be removed until the Impedance Comparator indicates the desired value has been reached.*
- ★ *Measurement of loss in capacitors of all types.*
- ★ *Dissipation-factor measurements of dielectric materials are considerably simplified and speeded.*
- ★ *The Impedance Comparator has already been incorporated in several automatic sorting machines. The ability to measure amplitude and phase angle independently, and to provide signals for accepting or rejecting a component or subassembly makes this instrument an extremely valuable part of any automatic sorting machine. Because no change in calibration is required for measuring different impedance levels, components of all types can be tested in rapid sequence. Automatic switching may be used with no adverse effects on operation because the guard circuit negates the capacitance of such switching.*

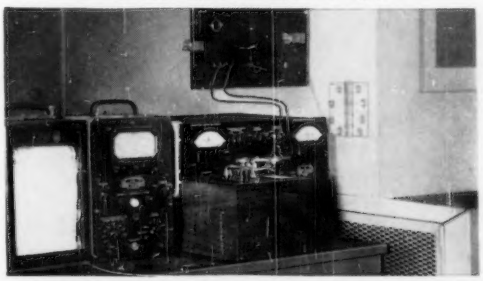
Type 1605-A
Impedance Comparator ... $790

Wide Range of Internal-Test Frequencies
100, 1000, 10,000 and 100,000 cps.

Impedance Range
Resistance: 2 ohms to 20 megohms
Capacitance: 40 $\mu\mu$f to 500 μf
Inductance: 10 μh to 10,000 h

Direct-Reading Meter Ranges
Impedance-Magnitude Differences:
0.3%, 1%, 3% and 10% of full scale.
Phase-Angle Differences:
.003, .01, .03, 0.1 radians full scale.

Over-All Accuracy
3% of full scale (.01% over-all accuracy on 0.3% impedance magnitude range).



A Written Record of Your Environmental Tests—The Impedance Comparator's built-in guard circuit permits accurate measurements of high- as well as low-impedance components in remote locations. Impedance changes caused by controlled temperature and humidity alterations in a test chamber can be automatically recorded. The photo shows the G-R Type 1230-A D-C Amplifier and Electrometer and an Esterline-Angus Recorder performing a typical environmental test; other commercially available recording instruments of 100 mv full scale sensitivity are suitable.

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- Speeds are positive under load as well as no load.
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- Meets and surpasses all ASTM and Federal specifications for accuracy.
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